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FRONT COVER

A VIEW OF DEODAR FORESTS, PARBATI VALLEY, HIMACHAL PRADESH FROM A PASSAGE HEWN THROUGH ROCK.

Photo—Sas. Biswas

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AGRO-FORESTRY LAND MANAGEMENT SYSTEM IN DEVELOPING COUNTRIES—AN OVERVIEW

V.M. SRINIVASAN* AND JON CAULFIELD**

Introduction

The alarming pressure of inflating population, especially in developing countries, and the dwindling supply of food and wood has gripped many countries around the globe. The carrying capacity of land in many developing countries is already overstretched. According to a recent FAO study, 56 of 117 developing countries did not have sufficient land resources to meet the food needs of their 1975 population at low levels of input use (Higgins *et al.*, 1983). These countries, covering an area of 2.2 billion ha, had 278 million people in excess of the *sustainable demographic density*. By 2000 A.D. this population is projected to reach 500 million. Accelerated deforestation and unscientific management have led to wood shortages in some countries which are even more serious than food scarcity. The World Resources Institute has estimated that 160 million ha of upland watershed in the Himalayas, the Andean range, the Central America, Ethiopian and Chinese highlands have been seriously degraded due to human interference. Extensive deforestation has resulted in raised river beds and the silting of dams. This has led to depleted water-carrying capacity and reduced irrigation potential. In India, projections by the National Commission on floods that an irrigation potential of almost 60,000 ha may be lost every year due to siltation amply illustrated the seriousness of the situation. The impact of deforestation not only disturbs developing countries but also developed countries because of ecosystem disturbances. Is today's slow rate of afforestation and drastic deforestation continues, wood famine is not far off. This may ultimately lead to food famine in developing countries.

The maintenance of tree cover is vital

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both for ecological balance and for economic sustainability of food-production systems. Agro-forestry systems (AF) of land management involving the integrated cultivation of woody perennials, arable craps and animals is a practical solution for these problems. A typical agro-forestry system (AF) through symbiotic economic and ecological interaction between the woody and arable components, helps increase, sustain and diversify the total net land output. An attempt has been made in this paper to provide an overview of different AF system and their impact on natural and other resources such as soil, climate, and economy.

Taxonomy of Agro-forestry systems

Agro-forestry can be defined as a sustainable land management system in which a woody perennial is raised in conjunction with arable crops and/or livestock, either in sequence or simultaneously on the same piece of land. Agro-forestry is a new name for an age-old practice that existes in various forms in most developing countries. Combe (1982) suggested 24 classes of agro-forestry systems, based on the kinds of associated agricultural production, the major function of the tree component, the spatial arrangement duration and combination of trees. Nair (1985), in contrast, classified it from the standpoints of agro-ecological zone and socio-economic aspects (e.g. silvipastoral systems for cattle production in tropical savanna or agro-silvicultural systems for soil conservation in tropical savanna). The major systems delineated in this paper are :

Shifting cultivation
Taungya cultivation
Home gardening or multi-tier system
Agri-silviculture system
Silviculture system
Silvi-pastoral system
Alley cropping or hedge row system
Agri-Silvi-Horti system
Wind breaks and shelter belts

Shifting cultivation : Shifting cultivation is a sequential agro-forestry system practiced by tribal communities on forest lands in which agricultural crops are grow up to a short fallow period (3-5 years) followed by trees. As soon as the tree phase is established, the practice is shifted to a new adjacent or distant forest area. This system, believed to have orginated in the neolithic period around 7000 B.C. (Sharma, 1976), is still common in many hilly areas of tropical Asia, Africa and Latin America. Due to demographic and land pressures, the shifting cultivation cycle has decreased from 30 to 40 years in the past to as short as 3-5 years in some countries. The system is practiced extensively in the northe-astern hill region and to some extent in other hilly regions of India constituting the main avocation of 50% of the tribal communities. Also referred to as "Jhum" cultivation in north-east and as "Podu" in southern states of India, is most commonly practiced in tropical to subtropical climates with high rainfall and high humidity (rarely below 75%). The conjoint crops are cereals, vegetables, tubers during the first five years of fallow, followed by bamboo, which progressively increase both in fequency and density in a 20-years fallow (Ramakrishnan and Toky, 1978). If the system is practiced over a cycle of 10-15 years, it has both

protective and productive benefits. In a 50-year fallow, bamboo gives way to broad leaved tree species. The early stage of shifting cultivation is a major cause of soil erosion; the attendant annual soil loss varies from 3.3 to 201 tones ha^{-1} (Singh and Singh, 1981).

Taungya system : To arrest land degradation resulting from shifting cultivation, a fairly successful system called taungya was developed and introduced in 1956 in Burma. It constitutes growing agricultural crops temporarily between regularly arranged rows of forest tree species. The government allots land to shifting cultivators and permites agricultural crops to be grown until the tree canopy is closed. When further intercropping is precluded farmers are shifted to new site. Meanwhile, the abandoned site develops into a full-fledged forest. Taungya was later adopted by many countries in Asia, Africa and Central America. The major forest species raised in taungya cultivation will naturally vary according to locality, but species like *Shorea robusta*, *Tectona grandis*, *Eucalyptus globulus*, *Acacia mearnsii*, *Pinus caribaea* etc. are very common. Intercropped agricultural crops also vary according to the agro-ecological situation. Some common crops are rice, millet, maize, gram, mustard, sugar cane, cassava, cotton, potato, turmeric and vegetables. If agricultural cropping is prolonged, not only the crop yields depressed, but in some cases tree growth also affected.

Under the taungya system as followed in Sri Lanka, the emphasis is on reforestation of land abandoned by non-resident cultivators within a period of three years. However, the area under the system is decreasing in Sri Lanka because of diminished interest by farmers.

Certain constraints imposed by the Government act as deterrents to the taungya system, but it holds promise as a viable system for the Forest Department to establish large scale plantations at low cost.

Homestead Agro-forestry system : Under this system, multi-tier cropping is practiced with trees, shrubs and herbs forming the different tiers. Besides producing a variety of foods and green manure, this system helps to control soil erosion. Very often livestock, poultry and fish are included to cater to the diverse needs of the farmer.

The leaf canopies of the components are arranged in such a way that they occupy different vertical layers with the tallest component having foliage tolerant of strong light and high evaporation demand and shorter components having foliage requiring or tolerating shade and high humidity. The major portion of the upper canopy goes to coconut, which is followed, in order of decreasing height, by crops such as black pepper and cacao. The lower storey is occupied by banana, cassava or other tuber crops. At the floor level, pineapple, vegetables and other herbaceous crops are grown. The composition varies according to the situation and need of the owner. A study conducted by a voluntary organization in the homesteads of Kerala reports a net income of Rs 1550, 3,848 and 3,950 from a 0.12 ha plot in the first, second and third year, respectively (Nair and Sreedaran, 1986). The components of the system in this study consisted of fodder, cassava, vegetables, a number of bananas, cloves and

coconut, with *Leucaena* being planted around the perimeter to serve as fodder for cattle. A cow, which served as the animal component, supplied the milk requirements of the owner and manure needs for the land.

A coconut based farming system is very common in Kerala. The increased microbial activity in the rhizosphere, high labor utilization and risk minimization are other benefits associated with the system (Nair, 1979). The majority of people in Bangladesh obtain their fuel, fodder and timber from homestead forests. According to one estimate, homestead forests produce about 70% of sawlogs and about 90% of fuelwood and bamboo consumed in Bangladesh (Byron, 1984).

Agri-silviculture system : In this system, which is gaining ground in most developing countries, arable crops are grown jointly with tree crops. Using this mixture, the rate of tree growth can be considerably increased and a favorable microclimate for arable crop growth is established for the first few years. In rainfed areas, it will prove a useful system because it provides some insurance against the vagaries of the monsoon.

In India, rice, maize and wheat were interplanted with poplar plantations. Yields were 4,800, 3,000 and 3,000 kg ha^{-1} on the 3 crops, respectively. The height of *Dalbergia sissoo*, when combined with peanuts, increased by upto 23% compared to monoculture in the initial stages. Inter-cropping of turmeric (*Curcuma longa*) in established plantations of *Tectona grandis*, *Shorea robusta* and other common forest species also resulted in significant responses (Singh, 1987).

A study of the effect of lopped and unlopped *Holoptelia integrifolia* on agricultural crops (moong and cluster beans) revealed yield to be low under shaded conditions (Table 1).

In another study, six month-old seedlings of *Acacia albida* and *Prosopis cineraria* were planted at different espacements and intercropped with pearl millet, cluster bean and moong beans. The results of crop production for three consecutive years revealed *P. cineraria* not to interfere with yields of moong and cluster bean (guar) under different spacing treatments. However, during the third year, cluster bean yield was adversely affected when grown with

Table 1

Crop yield (kg ha^{-1}) under lopped and unlopped 8-year old Holoptelia integrifolia.

Species	Unlopped tree	Lopped tree	Crop without trees
Moong (*Vigna mungo*)	201.75	252.75	246.21
Guar (*Cyamopsis triagonoloba*)	93.90	244.14	253.14

Lopping, in addition to providing fodder for cattle, enabled the agricultural crops to produce higher yields.

A. albida. In the closer tree spacing of *A. albida* (5×5m), the yield of cluster beans was only 650 kg ha^{-1} compared to 1280 kg ha^{-1} wider spacing (10 × 10 m). Compared to *P. cineraria*, *A. albida* had more root spread, which accounts for its better growth and increased injury to agricultural crops especially at closer spacing.

Similar studies carried out with *Leucaena* indicated reduction in the yield of associated crops of pigeon pea and blackgram but this was more than compensated for by an increase in wood yield (Table 2) (Prasad and Verma, 1983).

Reports from Pakistan indicate yields of agricultural crops to be higher when grown in association with *Eucalyptus camaldulensis* than with *Acacia nilotica*. The *Eucalyptus* and cotton combination was the best, providing not only higher yields of wood but also better monetary returns from cotton (Kermani, 1980). Similarly, yields of wheat under *Dalbergia sissoo* were significantly higher than those of wheat under *Eucalyptus citriodora*, *Populus deltoides* or *Bombax ceiba* (Khattak *et al.*, 1980). Wheat yield was depressed upto a distance of 5 meters from the tree rows, but total yield from tree-associated plots was higher than that of monocropping. Yields of sugarcane were affected upto 10 m away from the trees (Sheikh and Hag, 1986).

In the Philippines, an industry-related, agro-forestry system has become popular.

Table 2

Yield of Leucaena and intercrops.

Leucaena (alone)	*Leucaena* with intercrop (kg ha^{-1})	Crops (alone) (kg ha^{-1})
3.75 m × 25 cm - 3,700	(i) *Leucaena* 1,800 (3.75 × 25 cm)	—
	+	
75 cm × 25 cm - 14,000	Pigeon pea 1,280	Pigeon pea 1,650
	+	
	Sorghum 380	Sorghum 370
	(ii) *Leucaena* 1,400 (3.75 m × 25 cm)	
	+	
	Pigeon pea 1,370	Pigeon pea 1,690
	+	
	Black gram 208	B. gram 350
	(iii) *Leucaena* 1,200 (3.75 m × 25 cm)	
	+	
	Sorghum 460	Sorghum 660

In this project, launched by a private paper company, 20% of the land is used to raise agricultural crops and 80% for tree farming with *Albizia falcataria*, a fast growing tree for paper pulp on an eight-year rotation. Agro-forestry programs are gaining importance in Haiti, Kenya, Senegal and Nepal (Swaminathan, 1987), and farmers are voluntarily coming forward to adopt the system.

Silviculture (wood lots)

In many developing countries, farmers and community people grow trees in separate wood lots sequentially and the system is finding increased favour in the face of increasing fuel shortages. In Indian states such as Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat and Punjab, the lands suitable for agriculture are being brought under tree cover. Species like *Casuarina equisetifolia*, *Eucalyptus* spp., *Bambusa arundinacea*, *Pterocarpus santalinus*, *Leucaena leucocephala*, *Prosopis* spp. and *Acacia* spp. are commonly grown as wood lots. However, the main constraint is the long rotation period and the consequent delay in monetary returns. The high density, short rotation (HDSR) practice, also called silage harvesting is a partial answer to this problem, and can be used to cut down the waiting period. In general, if trees are planted at a wider spacing, they grow large more rapidly. But it is also known that if the plant population is increased, there will be shortages of nutrients. This creates a more competitive struggle for survival. In this those individuals who participate most vigorously register progress, whereas those who do not fall out. The modern concept in silviculture is "fast growing tree species do not differ in their growth rate because of spacing in the first few years". In Gujarat, *Eucalyptus* has almost replaced cash crops like cotton and sugar-cane under this HDSR practice. In Sweden, birch is grown at a density of 100,000 ha^{-1} (Srivastava, 1981). *Prosopis juliflora* is raised by a farmer near Ahmedabad upto a density of 2,500 ha^{-1} with cutting cycle of 5 years (Khanchandani, 1981). Raising of *Sesbania sesban* at an espacement of 30 × 30 cm at Dandeli, Karnataka (Bakhshish, 1975) and *Casuarina equisetifolia* at a density of 10,000 ha^{-1} (Ramakrishna and Toky, 1978) at Pondicherry have also been reported. Three-year volume production in *Eucalyptus tereticornis* and *Casuarina equisetifolia* under a high density of 40,000 ha^{-1} was nearly 10 times as much as in the conventional density of 2,500 ha^{-1} at a comparable age (Table 3) (Vinaya Rai and Srinivasan, 1987). The previously referred to *Eualyptus* trial in Gujarat, at an espacement of 30 × 30 cm (HDSR), gave the maximum economic return with a cost benefit ratio of 2.3 and IRR of 80%.

Hence, growing wood lot, in sequence under HDSR system is one of the advantageous agro-foresty system for farm lands.

Silvo-pastoral System : Under this system, fodder and other multipurpose trees are grown on grazing lands. If both agricultural crops and fodder grasses are grown with trees, it is termed an "Agro-silvi-pastoral system". Under this system trees will be leafless for a portion of a year and agricultural crops will be grown, then followed by fodder grasses. Trees suited for this system are *Acacia albida* in Africa and *Populus* spp. in India.

Table 3

Total volume under various plant densities in Eucalyptus and Casuarina (M^3 ha-1)

Density ha-1	Year after planting								
	1			2			3		
	E	C	Mean	E	C	Mean	E	C	Mean
40,000	12 6	11.8	12.2	54.1	53.1	53.6	305.6	320.7	313.1
10,000	2.4	3.1	2 7	13 9	27.5	20.7	83.4	165.9	124.6
2,500	0.2	1.0	0 6	4.0	5.8	4.9	27.1	22.9	30.0
	SEd		CD	SEd		CD	SEd		CD
Density	2 3		4.9	5.6		11.6	32.7		69 6
Species	1.8		NS	4.5		NS	26.7		NS
D × S	3.2		NS	7.9		NS	46.2		NS

E = *Eucalyptus* C = *Casuarina*

For the semi-arid region at Jhansi, India, the performance of *Leucaena leucocephala* was evaluated in a silvo-pastoral combination (Gill and Patil, 1983). The tree was compatible with a number of forage-production systems. The biomass production in association with a *Leucaena* was invariably higher compared to monocrop systems. Studies at Jodhpur, India, in 1970 involving *Acacia tortilis, Azadirachta indica, Albizia lebbeck* and *Holoptelia integrifolia* as tree components and *Cenchrus ciliaris, C. setigerus, Dichanthium annulatum* and *Panicum antidotale* as pastoral components between trees revealed no adverse effect on tree growth. But in another trial growth of *Acacia tortilis* was suppressed during the first three years when the tree seedlings were raised with *Cenchrus* spp. After the third year the plants attained better growth rates, indicating that by then the plants had, developed deep root systems and made the optimum use of soil moisture. The economic analysis of this system revealed that a combination of trees with grasses yields better returns compared with monoculture of trees or monocrop of grasses (Table 4) (Shankarnarayan *et al.*, 1987).

In African countries, the *Acacia albida* based agro-silvo-pastoral and silvo-pastoral systems are commonly used agro-forestry systems.

Alley Cropping

In alley cropping, arable crops are grown between hedge rows of planted shrubs and trees preferably leguminous species, which are periodically pruned to prevent shading the companion crops (Kang *et al.*, 1984). The shrubs and trees grown in the hedge rows will recycle the nutrients and suppress the weeds and control erosion especially on sloping lands.

Table 4

Economics of the Silvo-pastoral System with 7-year Acacia tortilis.

Treatment	Fuel Yield (Q. ha^{-1})	Grass Yield (Q. ha^{-1})	Revenue (Rs.)		
			Fuelwood	Grass	Total
Tree alone (10 m × 5 m)	60	—	3,000	—	3,000
Tree alone (10 m × 10 m)	32	—	1,600	—	1,600
1 + grasses	50	55.8	2,500	1,395	3,895
2 + grasses	28	52.9	1,400	1,323	2,793
Grasses only	—	460	—	1,150	1,150

Prunings from the hedge row plants are a source of mulch, fodder and green manure. The alley-cropping technique can, therefore, be regarded as an improved bush-fallow system with the following advantages.

1. Cropping and fallow phases are combined;
2. Longer cropping periods are possible with increased land-use intensity;
3. Rapid and effective soil fertility regeneration;
4. Reduced requirement for external inputs, and,
5. Scale-neutral, being flexible enough for use by small-scale farmers and for large mechanized production.

Alley croppin is also known as ' hedge row intercropping" (Anon. 19₀2).

On alfisols and associated soils, *Leucaena leucocephalu* and *Gliricidia sepium* were the most promising woody species for alley cropping (Atta-Krah *et al.*, 1985). Even on degraded land, prunings of these trees had higher nutrient yields when added to the soil; however, under a cut-and-carry system where prunings were continuously removed as fodder, the soil became impoverished unless nutrients from other sources were added.

Yields of maize and cassava, when alley cropped with *L. leucocephala* and *G. sepium*, were higher than when monocropped. It is estimated that *L. leucocephala* can contribute about 40 kg N/ha to the companion maize crop (Kang and Duguma, 1985). Results of long-term studies showed significant improvement in soil properties under alley cropping. These soils had higher soil organic matter and nutrient status than those receiving no prunings. Pruning added as mulch increased moisture retention in the top soil (Kang *et al.*, 1985).

With moisture being the primary limiting factor, especially in the semi-arid tropics, the size of alley width has a profound influence on the crop growth. Grain yield of hybrid maize and safflower increased as the width of the alley increased from 3.6 to 10.8 m (Table 5) (Chandrasekhariah, 1986).

Table 5

Effect of alley width on crop yield

Alley width (m)	Grain yield (kg ha^{-1})	
	Hybrid maize	Safflower
3.6	3337 0	516.0
7.2	3528.0	521 0
10.8	3783 0	602 0

Remarkable reduction in run-off and soil erosion has been reported when *L. leucocephala* was included in the production system (Kabeerathumma *et al.*, 1985). Similarly, observation at IITA, showed that with mechanized alley cropping on sloping land, soil that had been degraded after root-rake clearing and tillage was stabilized after *L. leucocephala* hedge rows were introduced than in the control area.

Studies on acidic ultisols in the humid tropics indicate that under these conditions woody species such as *Acacia barterri, Cassia siamea,* and *Flemingia congesta* were suitable for alley cropping. Cassava when alley cropped with *Acacia barterri* or *Cassia siamea* yielded more than in the monocrop (Kang *et al.*, 1985).

Spontaneous spread among the people is the most dependable proof of acceptability of a land-use technology. This has happened in the case of alley cropping over the past few years. The incentive to adopt alley cropping will increase as pressures on land increase (Vogel, 1986). Alley cropping is now practiced in most of developing countries such as India, Indonesia, Philippines, Sri Lanka, Nigeria, Pakistan, Bangladesh, China, Nepal and Kenya. Alley farming appears to be a low cost, sustainable agricultural technology and an attractive alternative to the prevailing shifting cultivation and bush-fallow system.

Horti-agri-silvicultural system

Under this system, long duration fruit crops, such as mango, sapota, jack, citrus, apple, peach and guava are grown and in between two fruit trees, and forest trees with small canopies, such as *Eucalyptus Casuarina, Leucaena, Dalbergia* and *Albizia* are grown at a close spacing. Usually nitrogen fixing trees are introduced. Between rows of trees agricultural crops, are grown. The system is a very viable system in which all the farm requirements like food, fodder, fruit, fuel, etc are obtained from the same piece of land with improved fertility and microclimate. This is very popular in Karnataka State in India The best combination being Mandrin orange + *Casuarina* + paddy or fodder sorgum.

Wind-break and shelter belts

Trees, mostly multipurpose trees, are usually grown on farm boundary in all agro-ecological regions of India. Apart from specific uses, like shade, fodder, fruit, green leaf manure and fiber, trees also help in reducing wind speed, improving local weather condition, and stabilizing sand dune in arid zones. Though trees may negatively affect adjacent agricultural crops by their root and shade effects, their service functions more than offset these.

Wind-breaks : Wind-breaks are one or two lines of tree planteda round the farm or field to reduce the wind speed and improve the microclimate of the field. *Leucaena*

leucocephala, when planted as a wind-break, increases the grain yield of agricultural crops and moisture availability in soil by reducing surface run-off and evaporation. In Niger, millett yields increased by 23% when neem trees were planted as wind-breaks (Swaminathan, 1987), similar results have also been observed in India when *Tectona grandis* and other tree species were planted around fields of agricultural crops. *Casuarina equisetifolia* and *Tectona grandis* are planted around plantations to minimize wind speed in South India.

Shelter belts: Shelter belts are wide strips of trees, shrubs and grasses planted in rows at right angles to the wind direction at regular intervals to deflect air currents, to reduce wind velocity and give general protection to the area from wind erosion. In Tamil Nadu, thousands of hectare of arid tracts like Thiruchendur, Vaikundam, where wind erosion is severe, are protected by shelter belts. Generally, areas up to 5 times the height of the shelter belt trees on the windward direction and 10 times the height on the leeward direction is protected against the ravages of wind.

At Bikaner district in Rajasthan, shelter belts of *Acacia nilotica* along with *Dalbergia sissoo* were established over a length of 102 km at regular intervals. The reduction in wind speed was more during the monsoon period (July-Sept.) than in summer. A 5-14% reduction in evapotranspiration was obtained due to reduced wind velocity. When *Cassia siamea* was used as shelter belt, soil loss by wind erosion was only 184 kg ha^{-1}, versus 566.8 kg ha^{-1} in the unprotected area.

Species tried and found suitable for shelter belts in Rajasthan include *Acacia tortilis*, *Prosopis juliflora*, *Cassia siamea*, *Azadirachta indica*, *Albizia lebbeck*, *Acacia nilotica*, *Tamarix articulata*, *Acacia salicina*, *Eucalyptus camaldulensis*, *Zizyphus nummularia* and *Inga dulce* (Shankarnaryan *et al.*, 1987).

Impact of Agro-forestry system on other farm resources

(1) Soil

The basic resource either for agriculture or forestry. By introducing trees, the physical and chemical properties of the soil are improved to a great extent. The magnitude of change depends upon the tree species, intensity of trees, type of soil, management practices associated with agricultural crops, environmental conditions etc. Inclusion of woody perennials on farmland can, in the long run, result in marked improvements in permeability, water holding capacity, aggregate stability, and soil temperature regimes. Although these improvements may be slow, their net effect is a better soil medium for plant growth. Trees improve soil fertility by addition of soil organic matter, through addition of leaf litter, and N_2 fixation by leguminous trees. In general, in arid and semi-arid lands, soil fertility improvement is a slow process. Under *Prosopis cineraria* plantation, silt and clay content of soil increased up to a depth of 120 cm, whereas in open field devoid of trees, changes in soil physical conditions were confined only to the top 90 cm. Improvement in soil physical conditions was accompanied by higher soil moisture beneath the tree (Aggarwal *et al.*, 1976).

Soil pH under the canopy was 8.0, compared with 8.2 in the open and this was true of electrical conductivity as well. The reduced pH beneath the tree is believed to be due to the higher contents of organic matter and soluble Ca and lower content of $CaCO_3$. There was also considerable enhancement in the soil nitrogen content, mainly due to higher leaf litter accumulation (Anon. 1982). Substantial increase in P, K and micro-nutrients were also noticed. Alley cropping, discussed previously, is preferable for improving soil fertility and productivity.

Soil Conservation : To maintain and conserve soil productivity soil is much more important than fertility improvement Recently research shows that the major ill effects of erosion is in lowering soil fertility, through removal of nutrients and organic matter in eroded sediment. For a given amount of erosion, the loss of productivity is greater in tropical than in temperate soils, and greatest on "old" highly weathered tropical soils. It is not possible to avoid erosion completely, but it can be controlled to the maximum extent by adopting agro-forestry systems like wind-break, shelter belt, alley cropping multi-storey tree gardens, planting across the slopes, etc.

Adverse effects of A.F. system on soils : There are some ill effects of trees on soil, but they can be eliminated by improved management technology. Some of the ill effects and the appropriate solutions are listed below.

Probable Effects	*Solution*
Fast growing species may deplete heavy soil moisture (eg. *Eucalyptus*, *Leucaena* & *Casuarina*).	Avoid such sp. in moisture constraint areas. Include drought tolerant species (*A. albida*, *Prosopis cineraria* etc.).
Nutrient loss from whole tree harvesting (*Eucalyptus* alone)	Adopt alley cropping technique (*Leucaena* with agricultural crop).
Monoculture of trees will lead to acceleration or deficit of a particular nutrient resulting in unproductive soil.	Adopt mixed planting especially with nitrogen fixing trees.
A badly managed tree stand or planting system will lead to soil erosion.	Adopt site specifications & species suitability etc.
Adverse chemical/biological effects of trees leading to acidification, allelopathy, toxic exudates, alternate host plant, etc.	Identify suitable tree spp. or compatible tree crop combination to overcome and nullify.

(2) **Microclimate**

Rama Krishnan an Shastri (1977) studied the effect of seven-year old *A. tortilis* trees on the microclimate of guar (cluster-bean) crop. The relative humidity under the tree canopy during the active cropping period was 7% higher than that in monocrop The air and soil temperatures were also less under the tree canopy. The sub-surface (0.5 cm) temperature under tree canopy was lowered by 1 0 to 10°C while at 30 cm depth, the reduction was 4-5°C.

(3) **Economic aspects of agro-forestry**

In considering agro-forestry land-use systems from an economic standpoint, emphasis is put on biological and economic interaction between the system components. Such interaction can be competitive and complementary as well as supplementary as a result of the special conditions created by the mixing of the system components in time or space.

In economic terms, ag o-forestry land use systems, compared with non-agro-forestry land-use systems, will have a higher output value at the same resource cost, or have the same output value at a lower resource cost. A higher output value in agro-forestry land-use systems may be obtained through an increase in :

1. Physical outputs,
2. The unit price of outputs.

Similarly lower resource costs in agro-forestry land-use systems may be obtained through a decrease in :

1. Physical input quantities,
2. The unit price of outputs.

As a whole, agro-forestry is recognized to be an economically viable land management system. Case studies conducted at Rajas han, Gujarat and Uttar Pradesh in India reveal that c mpared with pure agriculture or silviculture, agro-forestry land-management system gave the highest net present value (NPV), cost benefit ratio (2 28) and internal rate of return 80% to 97% (Mathur *et al.*, 1984).

SUMMARY

The agro-forestry system is an ideal land-management system for unproductive and degraded land. It also proves efficacious for soil conservation. Where protection is the primary objective, alley-cropping may serve as the prime candidate. For extensive areas subject to wind erosion shelter belts are an obvious choice. For orchards and crops susceptible to wind damage wind-breaks offer good protection. A multi-tier system gives year-round yields of one or the other produce In addition to the above benefits, agro-forestry system indirectly helps in building up the soil fertility, improving the microclimate, conserving the soil and water and improving the socio-economic condition of the farmer who practices it. Hence it is a versatile land management system for sustained yield.

विकासमान देशों में कृषि-वानिकी की भूमि-प्रवन्ध प्रणालियां—ऊपरिदृष्टि

वी०एम० श्रीनिवासन व जोन काउलफील्ड

सारांश

कृषि-वानिकी प्रणाली अनुत्पादक और विह्रसित भूमियों की आदर्श भू-प्रबन्ध प्रणाली है। भूमि संरक्षण के लिए भी यह उपादेय सिद्ध होनी है। जहाँ सुरक्षा करना ही प्राथमिक उद्देश्य हो वहां प्रथम कटाई उपवीथियों में लगी फसल की हो सकती है। विस्तृत क्षेत्र के लिए जहाँ वातक्षरण होता है वहां रक्षि पट्टियाँ बनाना ही प्रथम छांट होगी। बगीचो तथा ऐसी फसलों के लिए जहां वांधियां चलने से हानि पहुँचती है वातरोक पट्टियों से अच्छी सुरक्षा मिल जाती है। बहु-वितान प्रणाली बनाने से पूरे वर्ष भर किसी-न-किसी उपज से प्राप्ति मिलती रहती है। इन लाभों के अतिरिक्त कृषि-वानिकी परोक्ष रूप मे मृदा उवरता बढ़ाने, अणु जलवायु को सुधारने, मृदा और जल संरक्षित करने तथा इसे व्यवहार मे लाने वाले कृषक की समाजार्थिक दशा सुधारने में भी सहायक रहती है। इसलिए सतत प्राप्ति लेने की यह सर्वाधिक उपयोगी भूमि प्रबन्ध प्रणाली है।

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PRELIMINARY OBSERVATIONS ON VARIABILITY OF TEAK IN INDIA

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Introduction

Variability studies are important wherever selection forms the basis of genetic improvement. Selection of plus trees from available populations is the first step in initiating a breeding programme in forest trees. The number of trees to be scanned in order to locate a tree of technologically acceptable standard will depend on the genetic spectrum or distribution of the species, and the correlation of the characters under selection.

The selection differential depends on the amount of variation in each trait characterised by the standard deviation, the proportion of the population selected, and the number of traits being simultaneously selected. The amount of this differential between selected trees and the rest of the populations that is translated into genetic improvement in the following generations, depends on heritability. That is the degree to which variability in the trait between trees is influenced by genetic factors and which are transmitted from parent to offspring (Shelbourne, 1973).

In the Indian peninsular the northern limit of teak is, the Western Aravallis in Rajasthan at 24°42'N latitude thence eastwards through central portion into Jhansi District at 25°33'N entering Banda District. Thence in south easterly direction to Mahanadi river. From this northern limit it extends southwards to Tinnevelly and Travancore. Within its natural habitat there are plantation areas in Kerala, Karnataka, parts of Tamilnadu, Andhra Pradesh, Maharashtra and parts of Madhya Pradesh. Outside its natural habitat it is planted in the sub-Himalayan tracts of Uttar Pradesh, Assam, Bihar and Bengal.

Ecological variation

Although teak occurs in dry localities subject to great heat and drought in the hot season, it thrives best and reaches its largest dimensions in fairly moist warm tropical climate. In very moist tropical regions it tends to be replaced by evergreen forest. It extends into regions of slight frost but throughout almost the whole of its distribution frost is unknown. In the Indian peninsula it experiences in places an absolute maximum shade temperature upto about 118°F (48°C). But these extremes denote a drier climate than is favourable for its development. In moist parts of the west coast where it reaches larger dimensions than in the drier parts of the Indian peninsula, the climate is much more equable, the absolute maximum shade temperature varying from 95°F (35°C) to 100°F (38°C), and the absolute minimum from 55°F (13°C) to 62°F (17_0C). Normal

rainfall for its best development varies from 1240 mm to 3750 mm (Troup, 1921).

Teak is found on various geological formations. But the extent to which it flourishes depends largely on the depth, drainage, moisture and fertility of the resulting soil. It is fairly plentiful in Sandstone area of the Indian peninsula particularly on Vindhyan Sand Stones. But on hard matamorphosed sandstone or quartzite which disintegrate with difficulty teak becomes stunted and of poor growth. It flourishes on granite, gneiss and schists and other matamorphic rocks in North Kanara, Kerala, Annamalai hills, Coorg and elsewhere in the Indian peninsula. The soil resulting from granite and gneiss is often very sandy or gravelly and porous, and on ridges and in dry situations generally it may become unfavourable for the growth of teak.

Teak occurs on limestone in parts of Madhya Pradesh and locally in North Kanara. The great trap areas of the Indian peninsula are extensively covered with teak. As a general rule the soil is of no great depth and although teak is often remarkably plentiful, it is of small size. In the valleys and on lower slopes where there is some depth of soil teak attains fair dimensions in trap areas. As a rule it avoids laterites and where found on this rock it is invariably stunted. Only where the laterite is highly disintegrated and mixed with other rocks does it attain any size.

Seth & Waheed Khan (1958) recognises five types of teak forests. They are (i) very moist (ii) moist (iii) slightly moist (iv) dry and (v) very dry teak forest. This grouping is based on average annual rainfall, soil types, percentage of teak, associated species and type of under storey. Madan Gopal & Pattanath (1982) divided the country into a number of seed zones based on ecological factors and administrative feasibility to facilitate survey and documentation of species and collected data on species occurrence in each seed zone. It was then observed that even within each seed zone teak does not occur in continuous bands but in patches of greater or lesser extent separated by other tracts where it is absent or very local in occurrence. Champion & Seth (1968) believed that when a species of wide distribution is broken up into two or more unconnected areas such as eastern and western or northern and southern as in teak, the tendency to break up into local forms generally occurs. In this connection they recognize an eastern or Burma form and western or Indian form, and mentions that they are easily distinguishable from each other, though not so different as to lend to their recognition as of specific rank. Variations have also been observed in phenological characteristics such as time of flowering, fruit ripening and seed maturity in different localities. Variations in fruit size with varying locality factors in different seed sources have also been recorded and are presented in Table 1.

Variation in bole form and timber characteristics

Teak varies greatly in bole form, a characteristic which appears to show greater variation within a population than between populations. For example in Madhya Pradesh a survey was conducted in a number of teak growing areas such as South Seoni,

Table

Variations in locality factors and seed

Sl. No.	State	Seed Zone	Division	Range	Longitude
1.	Andhra Pradesh	AP XI	Narsipatnam	Lothagada	82⁰E
2.		AP V	Atmakur	Bairluty	78⁰E
3.	Karnataka	KT III	Sagar	Karedibetta	75⁰34′E
4.		KT IV	Hunsur	Devinachi	76⁰16′E
5.		KT VII	Yellapur	Dandeli	74⁰37′E
6.	Kerala	KL I	Konni	Kadambupara	76⁰51′E
7.		KL II	Malayatur	Kodanad	76⁰42′E
8.		KL III	Nemmara	Tunacadevu	76⁰47′E
9.		KL III	Wynad	Begur	76⁰20′E
10.		KL III	Nilambur	—	76⁰13′E
11.	Madhya Pradesh	MP I	Hoshangabad	Bori	78⁰2′E
12.		MP II	North Bastar	Sonpur	81⁰10′E
13.		MP V	North Raipur	Loan	85⁰5′E
14.		MP VI	Bilaspur	Khudia	82⁰E
15.		MP VIII	Durg	Daundilohara	81⁰1′E
16.		MP IX	Umrai	—	80⁰9′E
17.		MP X	Panna	Mandla	80⁰2′E
18.		MP II	Damoh	Ajaigarh Bagoni	80⁰E
19.		MP XII	North Betul	Betul	77⁰9′E
20.		MP XIV	South Khandwa	Piplod	76⁰5′E
21.		MP XV	Guna	Maksudargarh	77⁰2′E
22.		MP XII	North Seoni	Ghansore	80⁰E
23.	Orissa	OS I	Khariar	Khariar	82⁰85′E
24.		OS III	Angul	Purankota	84⁰50′E

1

weight in different seed sources of teak

Latitude	Altitude (m)	Annual Rainfall (mm)	Time of Seed Collection	No. of fruits per kg.
17° N	600	1345	March	1540
15°N	360	875	April	2660
13°56′N	567	1000	Feb./March	1848
12°13′N	860	2500	Feb./March	1674
15°14′N	558	2500	Feb./March	2400
9°13′N	40	2500	April/May	2056
9°46′N	50	1500	Feb./March	1700
10°7′E	521	2500	March/April	1684
11°48′E	750	2500	March/April	1115
11°16′E	40	2500	March/April	1884
22°4′N	350	1400	April	2376
19°15′N	600	1500	March	2288
21°3′N	400	1400	March	2646
22°2′N	275	1600	March	2572
20°5′N	300	1400	March	2306
23°6′N	400	1400	March	2686
24°8′N	500	1200	March	2497
23°10′N	300	1200	March	2374
22°1′N	600	1400	March	2367
21°6′N	300	1000	March	2433
24°1′N	300	1000	March	1680
22°N	500	1255	January	2200
20°1′N	530	1298	May	2530
20°5′N	122	1570	April	1440

East Chindwara, North and South Betul, Harda and Hoshangabad Forest Divisions and it was observed that arrested buds, knots, and twisted grain, were present in varying degrees even in the most optimum populations apart from variations in the diameter and length of free bole. However very little studies have been carried out to relate variations in bole form to locality factors. Teak also varies greatly from locality to locality in timber characteristics such as colour, grain, texture and figure. In Seoni, Kanker and parts of Bastar in Madhya Pradesh the timber is a golden yellow colour with the heartwood blending into the sapwood. In Khariar division of the same state, adjacent to Raipur, teak timber is known to have good decorative grains. Teak wood of Godavari forest of Andhra Pradesh is highly priced for furniture and cabinet making because of its ornamental figuring. Teak timber in Rajulmadugu locality of Adilabad division of Andhra Pradesh has rose coloured heartwood and fetches a higher price.

Morphological variations

Morphological variations in the form of a distinct variety known as Teli variety based mainly on leaf characteristic and resistance to skeletoniser is found in North Khandwa Forest Division of Madhya Pradesh. In East Kalibhit Range Telia variety of Teak occurs over an area of about 65 sq. km. There are also rich pockets of this variety in Damoh, Sagar, Durg and Bastar divisions. The Telia variety of Teak has been reported to occur in other parts of India also such as in Virnoli range of South Kanara Division of Karnataka Some variations have also been observed in the morphology of seedlings such as rosette formation and three Cotyledons instead of two These variations were more marked in seeds obtained from Kerala.

Variation in floral biology

Inflorescence is a large dichotomously branched terminal tomentose cymose panicle. But trichotomously branched inflorescence have also been observed occassionally. Flowers are very small white, scented, regular, bracteolate and bisexual. Calyx is six lobed, stellate, pubescent, globose in bud, campanulate in the open flower, and persistant forming an enlarged membraneous enclosure for the fruit. Corolla is rotate, generally six lobed, slightly pubescent. Corolla tube is very short. Stamens-six in number, sometimes five in number generally equal in length, inserted on the mouth of the corolla tube Filaments are about 1 mm long. Ovary fleshy, hairy, 4-celled with one ovule in each cell. Stile generally longer than the stamens Stigma is bifid. Variations were observed mainly in the number and length of the stamens, the length style, the number of ovules, as well as in the branching of the inflorescence.

Pollination takes place by insects. The structure of the flower indicates adaptation for cross pollination as the stigma is placed well above the level of the anthers. The probability of a certain amount of selfing however cannot be ruled out due to variations in the length of the style and stamens. Detailed study on the rate of selfing and outcrossing in this species does not appear to have been carried out in India. Information is also not available on embryological studies of

teak and details of the fertilization process. Some observations recorded on emptiness in teak fruits from different sources and failure of seed formation emphasise the need for a more thorough study of the fertilization process in teak. But judging from the fact that an inflorescence contains buds, flowers and small fruits all mixed up together, it may be concluded that the period between pollination and fertilization is quite short. Seed maturity however takes a longer period as fruits ripen only after about six or seven months after the flowering period. Fruits ripen from November to January and fall gradually.

Variation in Seed Biology

Fruit is a drupe, globose, hairy and enclosed in the enlarged calyx. It has an outer spongy coat, grey-brown in colour, and an inner woody coat enclosing one to four locules containing the seeds which are obovoid in shape, and covered by a thin papery brown seed coat. As the seeds are very delicate and deeply embedded in the locules within the woody coat of the fruit, and susceptible to damage during extraction the fruits are sown whole. Each fruit may contain one to four seeds depending upon the number of locules. Different seed sources have been observed to have varying number of locules in the fruit. Even within a seed lot however the number of locules have been observed to vary from one to four.

Germination studies carried out by the Indo-Danish Project Hyderabad on 36 sources of teak seeds confirmed earlier findings (Gupta & Pattanath, 1975) that dormancy in Teak seeds are of three main types viz. (a) presence of germination inhibitor in the outer spongy coat of the teak fruit which was water soluble and could be removed with alternate soaking and drying of the fruit for about a month or more (b) a nutrient imbalance in the seeds which could be set right by soaking the fruits in sachs nutrient solution and drying alternatively a number of times before sowing (c) a physiological dormancy known as after ripening which requires the fruits to be stored for one or two seasons after collection before the seeds respond and germinate even with pretreatments. Seeds suffering from after-ripening do not respond to any type of pretreatments, if sown immediately after collection such as teak seeds collected from West Chanda and Dhaba in Maharashtra and Nandiyal in Andhra Pradesh.

Teak seeds from all 36 sources were properly sampled for the germination tests, and for each source three treatments were given with four replicates in each treatment. Different treatments were as follows : (i) soaking in water for 12 hours and drying for 12 hours alternately for a month every day before sowing, (ii) soaking in sachs nutrient solution for 24 hours and drying for 24 hours alternatively every day for a month before sowing, (iii) no pretreatment. Tests were carried out with four hundred fruits per treatment in germination trays filled with sand under laboratory conditions, first in the very season in which the seeds were collected, and later in the second and third season after the year of collection for those fruits that did not respond to pretreatment in the initial tests (viz. the season in which the seeds were collected). It was observed that

in each treatment germination took place in two or three flushes with each flush lasting about ten to fifteen days. The intervals between the flushes were nine to ten months. Based on these tests recommendations for pretreatment of different seed sources of teak are presented in Table 2 for those seed sources which germinated in the same season or the next season after its collection. These recommendations are of practical importance for raising nursery seedlings.

Table 2

Pretreatment of Teak seeds recommended for different seed sources

Sl. No.	State	Locality	Pretreatment	Approximate germination per cent expected with recommended treatment.
1	2	3	4	5
1.	Andhra Pradesh	Adilabad	Alternate soaking and drying	50 in three flush
2.		Paloncha	-do-	65 in one flush
3.		Srikakulam	-do-	75 -do-
4.	Assam	Holloidangabeat	-do-	70 -do-
5.		Garohills (Daringiri Range)	Sachs nutrient solution	80 in two flush
6.		Garohills (Dinadubi Range)	-do-	40 -do-
7.	Gujarat	Godhara	Alternate soaking and drying	40 in one flush
8.	Kerala	Punnalur	No pretreatment	80 -do-
9.		Konni	No pretreatment	75 -do-
10.		Nilambur	No pretreatment	60 -do-
11.	Madhya Pradesh	North Balaghat	No pretreatment	40 -do-
12.		West Bastar	Sachs nutrient solution	70 -do-
13.		South Chindwara	-do-	70 -do-
14.		Narsimhapur	-do-	75 -do-

(*Contd...*)

1	2	3	4	5
15.		North Betul	Sachs nutrient solution	50 in one flush
16.		Jashpur	-do-	70 -do-
17.		North Bastar	Alternate soaking and drying	80 -do-
18.		South Seoni	-do-	70 -do-
19.		South Bastar	-do-	80 -do-
20.		Korea Div, Baikuntpur	-do-	50 -do-
21.		Durg	-do-	70 -do-
22.	Maharashtra	Satara	-do-	50 -do-
23.		East Nasik	-do-	80 -do-
24.		Thana	-do-	80 -do-
25.	Orissa	Puri Division	-do-	80 -do-
26.	Uttar Pradesh	East Dehra Dun	Alternate soaking and drying	50 -do-
27.		West Kankar	-do-	40 -do-
28.		North Gonda	-do-	30 -do-
29		Lansdown Forest Division	No pretreatment	75 in three flush
30.		Midnapur	Alternate soaking and drying	50 -do-

Discussion

The evolutionary possibilities of a population are set in each case by its genetic potentialities modified by conditions prevalent in the environment. The most important evolutionary mechanism is adaptation whereby a species by its character combinations, metabolic processes and development pathways is able to survive in a given ecological niche. It is a recognized fact that forest trees have evolved inherent adaptations to the factors of the environment at the site where they grow, so that species with a wide geographic distribution exhibit variations some of which are apparant such as morphological and phenological variations, as well as variations, which are not so apparant such as physiological variations in the form of seed dormancy. A knowledge of all these variations within each species selected for improvement is important in different stages of a tree breeding programme.

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SUMMARY

Forest trees with wide geographic distribution develop inherent adaptations to factors of the environment at the site where they grow in order to survive in a given ecological niche. These adaptations which are the result of prevalent environment are controlled to a great extent by genetic potentialities. When a species is taken up for breeding work it is necessary to study these variations to draw up a strategy for improvement.

As teak is a species with wide geographic distribution and is raised as plantations right from Kerala in the south to as far north as Uttar Pradesh, it wasdecided to make a preliminary study initially to be followed up later by a more detailed study of intra and interpopulation variations. The results of the preliminary studies are presented in this paper. As variations in seed biology was studied a little more in detail than other characteristics, recommendations have been made on the pretreatment requirements of teak seeds collected from different seed sources and are presented in the form of a table. These recommendations are of practical importance for raising nu, sery seedlings.

भारत में सागौन की वि भिन्नत ओं के संवन्ध में कुछ प्रारम्भिक पर्यावलोकन

पी०ई० बेडेल

सारांश

वनों के वृक्ष जिनका भौगोलिक विस्तार अधिक होता है किसी बिशिष्ठ परिस्थिकीय खण्ड में पनपने के लिए उस स्थान पर जहां वे उग रहे होते हैं पर्यावरण कारकों के प्रति अपनी निहित अनुकूलनताओं का विकास कर लेते हैं। ये अनुकूलनताएं जो प्रसृत पर्यावरण के परिणाम स्वरूप बनाती है, वहुत सीमा तक जननिक सभाविताओ से नियन्त्रित होती है। प्रजनन कार्य के लिए किसी वृक्ष जाति को लेते समय उसकी इन विभिन्नताओं का अध्ययन करना उसके सुधार की समरनीति तैयार करने के लिये अनिवार्य होता है।

सागौन विस्तृत भौगोलिक विस्तार वाली वृक्ष जाति है और रोपवनों में धुर दक्षिण में केरल से लगाकर, उत्तर में उत्तर प्रदेश तक उगाई जा रही है, यह निर्णय किया गया कि इसका पहले प्रारम्भिक अध्ययन किया जाए और इसके बाद इसके विभिन्न समुदायों की आन्तरिक और पारस्परिक विभिन्नताओं का अधिक विस्तार से अध्ययन किया जाए। प्रारम्भिक अध्ययन से मिले परिणाम इस अभिपत्र में दिए गए हैं। इसके अन्य लक्षणों के मुकाबले में इसकी बीज-जैविकीय विभिन्नता का अध्ययन थोड़ा अधिक विस्तार से किया गया, इसलिए विभिन्न बीज स्रोतों से एकत्र किए गए सागौन के बीजों का पूर्वोपचार करने की आवश्यकताओं के विषय में सिफारिशें की गई हैं जिन्हें यहां सारिणी रूप में दिया गया है। ये सिफारिशें रोपणी के पौधे तैयार करने के लिए व्यवहारिक महत्व की हैं।

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TROPICAL RAIN FORESTS OF INDIA—THEIR MANAGEMENT AND REGENERATION

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Introduction

Tropical Rain Forests of India have been classified as Tropical Wet Evergreen Forests They are found in three formations; the Western Ghats, the Andaman and Nicobar islands and the North-East Region of the country. They apparently appear similar in their structure and general floristics but there are discerning variations not only in the general floristic composition but also in the occurrence, typology and mixing of the species. This variation is brought about by edapho-climatic factors and to some extent by geo and physiographic locations. Despite these subtle differences there is a general similarity and that is the basis of their classification together.

The Western Ghats have the seasonability of rainfall which may be (2000 - 8000 mm annually) and high temperature. The number of rainy months decrease from 8 to 4 as one proceeds north from Kanyakumari to Mahabaleswar. In the central and northern portions of the Western Ghats over 80 per cent of the annual precipitation is received during the month of June to August and invariably the months of December to April are dry. However in Kerala and Tamil Nadu part of the Western Ghats the rainfall is better distributed. By and large the minimum temperature does not go below 12°C in the zone of TRF and the maximum may reach upto 45°C at the canopy level at the higher reaches.

The islands of Andaman and Nicobar have better distribution of rainfall as they get rains both from South-west and North-east monsoon, like the lower portion of the penninsula. Here only the months of February and March are practically dry and the temperature range is similar to the Western Ghats region.

The above two regions are generally in true tropics. But again there is variation between the two on geological formation and the soil types. Soils in A & N islands are generally sandy in nature while those in the Western Ghats are laterilic or have tendency to laterization. Forests on the islands are generally on lower elevations which are on gently sloping ground while in the Western Ghats the forests now existing are on moderate slopes. This adds a new dimension to their silvicultural management.

The rainfall pattern of the North-eastern region may be comparable to those

of the islands, but the temperature is distinctly lower. The minimum may go down to 6°C and the maximum may reach up to 38°C The high humidity and low temperature give rise to invariably intermitant presence of clouds over the entire tract particularly in non rainy months. The soil in the area is also different. It is sandy loam in the plains and loamy on the slopes. In any case it does not have the danger of laterization. By and large the water table is high in this tract. The TRFs here are of two distinct types—those on the plains and the other on the hill slopes.

Type of Forests

The forests of three zones have been very broadly described and at the best they can be called comprehensive and not final. These are more like the broad indications where the effort is to bring about the characteristic differences.

Western Ghats : The forest here now exists on higher reaches, though in the past in the southern parts they must have existed even in the coastal plains as the relic vegetation indicates. These forests at the best can be called as Seasonal Rain Forest as they generally experience 3-4 dry months in a year. Dipterocarps are the prominent group in these forests too. Some of the most important spps. of the overwood are *Dipterocarpus indicus*, *Vateria indica*, *Hopea parviflora*, *Palaquium ellipticum*, *Calophyllum tomentosum*, *Mesua ferrea*, *Antiaris toxicaria*, *Kingiodendron pinnatum*, *Cullenia excelsa*, *Acrocarpus fraxinifolius*, *Syzygium gardneri* and others. The most characteristic and unmistakable feature of these forests, is the well defined layer of underwood spp. which has several *Garcinias*, *Myristicas*, *Nothopegias*, *Drypetes elata*, *Lansium anamalayanum*, *Humboldtia brunonis* and others. None of the spp. either in the overwood or in the underwood form more than 5 per cent of the total crop, if we consider their distribution as a whole. These forests are species rich. May be the seasonality of the climate has created such a mixture. The leaf fall in these forests is cyclic and it always keeps the ground protected.

Andaman and Nicobar islands : These islands are unique in their own way. Except the land that has been cleared for other uses, right from the sea-fringe to the hill tops there is vegetation of one type or the other. The parts of the island where sea water reaches during the high tides have mangrove forest. Thereafter in a fringe there are littoral forests. The steep and higher hill tops have stunted type of evergreen forests. The other portion in between has Deciduous, Semi-evergreen and Evergreen formations based on the rainfall, soil and its moisture retention capacity.

These forests are similar to those in Western Ghats and have Dipterocarps as the dominat group of trees. The overwood spp. are *Dipterocarpus grandiflorus*, *D. turbinatus*, *D. kerri*, *Artocarpus chaplasa*, *A. gomeziana*, *Callophyllum* spp., *Hopea odorata*, *Amoora wallichii*, *Sterculia alata*, *S. compannulata* and occasional *Pterocarpus dalbergioides*. The understorey has *Myristicas*, *Xanthoxylum andamanica*, *Baccaurea sapida*, *Memecyelon* spp. and others.

North - Eastern India : Tropical Rain Forests of North Eastern India fall into a

sub-tropical zone and they have some elements of that vegetation in them. The most striking feature of these forests is that the multi-species dominance of the top canopy or the overwood spp. that are capable of being emergents, is not conspicuous. The dominance of the top canopy is shared by a few spp. No doubt here also Dipterocarps are the dominant overwood group.

Basically the forests are found under two distinct locations. On plain, which are alluvial and on hill slopes which generally have non-alluvial but favourable soil. The TRFs on the plains have a large proportion of *Dipterocarpus macrocarpus* in the overwood and generally the co-dominants are *Mesua ferrea*. This is rather an interesting feature that Mesua here is not a dominant overwood spp. but like in A & N islands, it is in a lower storey. Other important spp. of the top canopy are *Amoora wallichii*, *Sapium baccatum*, *Artocarpus chaplasa*, *Vatica lanceaefolia* and *Altingia excelsa*.

What is more striking here is the conspicuous absence of the typical underwoods found in the forests of Western Ghats, like *Myristicas*, *Garcinias* and others in those large proportions. No doubt in these groups there is a *Garcinia* spp. and two spp. of *Polyalthia*, *Baccaurea sapida* and a *Myristica* spp. Environmental conditions of the Western Ghats being more severe the forest formations seem to be better endowed with a distinct layer of overwood for better protection of soil and retention of moisture.

The formations on the hilly locations have more of *Shorea assamica* and *Altingia excelsa*.

Past History of Management

These forests located in different parts of India have to some extent a similar history exploitation. In the north and western coast with the spread of civilisation first onslaught on them must have been for domestic and maritime or riverain constructions such as boats. However in Andamans this process would have begun only with the settlement of the island towards the end of the 18th century. Further exploitation of these forests on the main land increased around in the second half of the nineteenth century. The 1850's saw the advent of railways, new and expanding activity needing land and timber and the 1860's onwards the demand for tea-chest timber and plywood increased. The extent of removals from these types of forests or cleaning of these areas for tea cultivation in North-east region is not fully documented. Similar onslaught in the south was for coffee and rubber cultivation.

Two other important historical happenings of the time are of relevance. The second war of Burma in 1852 was a clear case of British comercial interest, in the timber resources of Burma. And the Revolt of 1857 lead to a situation that British shed the semblance of liberalism and the lip-service that they were 'preparing' Indians for self role. They became more reactionary in approch. Many top positions in important Department including forests were reserved for British. There was lot more centralization of power and most of the revenue was being spent on railways and army. Peasants were being exploited

very heavily. All this lead to the clearance of forests in various parts of the country for various purposes.

During the first world war and subsequently these forests were exploited for war supplies, playwood logs and for matchwood This process continued and got more accentuated after independence of the country. In addition to these recognised effects there was the factor of shifting cultivation all over. Many parts of the North-eastern region colonised by bamboos are said to be forests which eventually became bamboo brakes.

After the independence the country had to face a unenviable situation; scarcity of food and paucity of resources for development. The forests and mines are the first casualities of a developing country. Clearances for cultivation, hydel power, roads, colonisation and the like, took palce. Removals rather on larger scales than what could be absorbed by the resilience of these ecosystems, were effected for ply logs, matchwood and other timber. As a result many of these tracts are now in a retrograde or degraded state. There are clear examples of such happenings in the Western Ghats and North-east region of the country.

Fragility of these forests

All the world over these forests are recognised as the most fascinating yet complex, and fragile ecosystems. They sustain themselves on a very delicate balance between the environment and the vegetation. The multi-tiered structure with abundance of the floristics is a pointer to the variety and the delicate balance. They are resilient enough to tolerate the natural disturbances on which they have developed but large scale removals coupled with attendant damage to the surrounding vegetation has more often than not left them in disturbed conditions.

The extent of removal from these forests have often been on the higher side. The fact is that in the national planning also till the end of 1960's the foresters were invariably questioned to justify the cause and account for the reason for the situation that country had 23% of land area under forest but it was contributing only 2% to the GNP. The writing was on the wall—the pressure for more revenue from the forestry sector—an unavoidable situation for any developing country provided it has forests. In addition there were separate removals from the same forests for plywood, matchwood, and railway sleepers. In effect the area was worked for one to several years. These forests are very susceptible to repeated disturbances. It may be said that from among the multitudes of species only a particular one is suited for a particular size of gap, type of existing accociation and the adaption factors. It may come up on the local provided the seed is available. The repeated disturbance keeps changing the situation and hence the choice of the eventual spp. No wonder that over a short period of time a lush green Rain forest may turn into a grass land. I would like to clarify this point. In the low level TRF's of Western Ghat if a patch of land gets cleaned due to man-made or natural reasons and it does not get a burn then the colonisers that come up are *Macranga peltata*, *Trema orientalis*, *Cellicarpa lanata* and *Lea chinensis*. However, if the

land gets burnt then the colonisers are *M. peltata* and *T. orientalis* only Further if the same patch gets burnt again only *T. orientalis* comes up. And a further fire on the same land leads it to a grassy blank. In the North-east region presumably it leads to Bamboo brakes The *Ochlandra* brakes of the Western Ghats may be a result of the past shifting cultivations.

Two important points that have been made above are :

(i) Heavy past exploitations.

(ii) Repeated exploitation from the same area for different end uses.

These two have lead to degradation of forests all over.

Regeneration of the forests

Regeneration of a forests initially is a response to its present and potential utilization. Most species from these forests had no immediate use till the mid nineteenth century except that some removal were taking place for boat building and such other uses. This was a local, domestic and bonafide utilization. The commerical utilization of these forests first seems to have started for ship-masts and other structures, railways, then for war supplies, plywood and matchwood in that order.

From Western Ghats the first few spp. to have been removed are *Calophyllum tomentosum* for ship mast, *Hopea parviflora* for railway sleeper and *Dipterocarpus indicus* for plywood. From North-east region it was *Terminalia myriocarpa* for tea chest and railway sleepers and then *Dipterocarpus macrocarpus* for plywood. From the islands the first spp. to be exploited was Padauk for construction and cabinet purpose then the Dipterocarps for plylogs.

The selective removals have a direct bearing on regeneration. Trees of one or two spp only of and above certain dimensions were removed. This was a process of creaming-off the desirable. This did not really lead to any organised regeneration effort. Due to the logistic and economic considerations these removals took place from the areas where there was concentration of the desirable species. The back up regeneration operations were inadequate—there did come up a vegetation but to what extent the desirable composition and original structure was restored is questionable.

With the advent of the Working Plans this method was given the shape of Selection system-which was a misnomer in this case. It was not the classical Selection system where all trees of and above a certain dimension were removed, but it was a Selective system Nonetheless the Working Plans gave the working of these areas a time schedule. Once again only in certain parts of the country the regeneration of these forests has been upto the desirable level. The only successful regeneration efforts are the Andaman Canopy Lifting system and the Aided Natural Regeneration of Arunachal Pradesh.

Many past efforts of clear felling and dibbling or planting, and various types of Shelterwood systems have not given the desired results. The reasons are easy to discern. The environmental factors that give rise to this magnificient vegetation are

harsh in some ways—the excessive rainfall in a concentrated period; the high and dessicating temperature in dry months; slope of the land and the high velocity winds. These are detrimental to the regeneration. Further the auto-ecological factors, the wide amplitude of the species which grow under 1% of the canopy level insolation and go through the entire range and eventually face 100% sunlight are also inhibitory to fully exposed regeneration. Added to this is the uncertainty of seed as the bearing in these species is periodic.

Only a particular set of combinations which ensure filtered light and partial shade to the young seedlings, support regeneration. Further it has been observed that there is a distinct periodicity in bearing of these species. By and large these seedlings grow initally under shade of other trees, provided the shade is not too thick which may prohibit their further growth. The fact is that many of these seedlings are capable of surviving for a very long periods under total shade, sometimes even upto 20 years without putting on any appreciable growth. However when there is availability of optimal light they start shooting up reasonably fast. For normal growth of these species lateral light is essential from pole stage onwards Thus the regeneration needs partial shade alongwith some lateral light and also the presence of adequate seed bearers. Besides all these, at the ground level, freedom from weeds and other climbers. The combination of all these has to be found if the regeneration has to come up properly. This type of situation can only be created by considerable effort as in case of the Andaman Canopy Lifting system. Further the factors of soil erosion due to generally excessive rain fall and high temperatures particularly during the dry months prohibit the regeneration very considerably. It may be stated that by and large it is rather difficult to get adequate regeneration in these forests without adequate regeneration bear testimony to this statement. However the present problem is restocking of the degraded TRFs. Their total protection from fire and biotic interferences coupled with regeneration efforts can perhaps achieve this. The areas being worked currently need more attention. Minimum removal (maximum 5 mature trees per hectare) and Aided Natural Regeneration can only help proper restocking of the areas. A study in TRFs of Malaysia indicated that removal of 3 per cent of Growing Stock from such forests eventually lead to disturbance/damage of 52 per cent stems. The system of Aided Natural Regeneration envisages dependance on natural regeneration, aiding it by various cultural operations, including planting of nursery raised seedlings in required quantities and after care of sapplings till they are fully established. This method is fairly successful in Arunachal Pradesh. Wherever possible this method can also be adopted for restocking the degraded TRFs.

SUMMARY

Tropical Rain Forests in India are found in three regions; the Western Ghats, the North-east region and the Andamans and Nicobar islands. They are comparable in several respects yet they have their characteristic differences in floristics and composition. These forests

ecosystems are very fragile in nature. They have been rather worked heavily in the past and have not regenerated very successfully in most cases. The delicate balance of light and shade requirement of the spp. that occur in these forests is a key factor in their regeneration. Two of the successful systems of regeneration are the Andaman Canopy Lifting System and the Aided Natural Regeneration. The forest of the three regions have been broadly described and their past management has been generally discussed. A suggestion has been made for their regeneration and restocking.

भारत के उष्णदेशीय वर्षा वन—उनका प्रबन्ध और पुनर्जनन

एस०एन० रय

सारांश

भारत में उष्णदेशीय वर्षा वन तीन प्रदेशों में पाये जाते हैं— पश्चिमी घाट, पूर्वोत्तर क्षत्र तथा अंडमान व निकोबार द्वीप। कई बातो में वे परस्पर तुलनीय हैं परन्तु पादपमात्रिकी और संगठन मे उनमे विशिष्ट अन्तर भी मिलते हैं। ये वन परिस्थितसहतियां प्रकृतित: बहुत भगुर प्रकार की है। विगत मे इन्हें बहुत अधिक काटा गया है, अधिकांश मामलों में ये सफलतापूर्वक पुनर्जनित नहीं हो पाई। इन वनो मे होने वाली वृक्ष जातियो की प्रकाश और छाया आवश्यकताओं का नाजुक संतुलन रखना इनका पुनर्जनन कराने में एक प्रधान कारक है। इसके पुनर्जनन की दो सफल प्रणालियां अण्डमान वितान उठाने की प्रणाली और सहायता प्राप्त प्राकृतिक पुनर्जनन प्रणाली हैं। इन तीनों प्रदेशों के वनो का मोटे तौर पर वर्णन किया गया है तथा उनके विगत प्रबन्ध का सामान्य विवेचन किया गया है। उनके पुनर्जनन और फिर से वृक्ष पूरित करने के विषय मे सुझाव भी दिया गया है।

FRUIT MATURITY AND INTERRELATED EFFECTS OF TEMPERATURE AND CONTAINER ON LONGEVITY OF NEEM (*AZADIRACHTA INDICA*) SEEDS

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Introduction

Azadirachta indica A. Juss. (neem) is an important tree widely grown in tropical regions of India for its medicinal uses, timber, shade, fodder for camels and oil seeds. The species is of tremendous potential for reclamation of degraded lands in dry zones of the country and hence included under social forestry and wasteland afforestation programmes. The tree is propagated through seeds which are short-lived i.e., loses viability within few days. It is, therefore, frequently recommended that the seeds should be sown soon after collection (Troup, 1921; Dent, 1948). But in actual practice a gap often encounters between seed collection and sowing schedules. It is also difficult to transport the seeds to long distances without impairing their qualities.

There is no available record on influence of fruit maturity and interrelated effects of temperature and container on longevity of this seed. However, during the course of routine testing of forest tree seeds in the Seed Testing Laboratory of FRI, it was found that neem seeds stored in well aerated containers remained viable for comparatively longer durations at room temperature. Present investigation was, therefore, taken up in order to determine (1) indices of fruit maturity (2) effect of fruit maturity on seed germination and longevity and (3) interrelated effects of temperature and container on seed longevity. It is hoped that the optimum conditions determined to prolong viability will be of immense importance in handling of this seed after collection and during transportation.

Materials and Methods

Seed collection and extraction : Flowering of neem was observed in Saharanpur district during second week of May, 1986. For studies on indices of maturity a single tree was selected and first fruit collection was done after 4 weeks of flowering and subsequently after every two weeks. After 14 weeks of flowering there was no seed available on the tree.

Immediately after collection fruits were heaped with leaves on floor and covered with canvas for pulp decomposition till the seed becomes easily extractable on pressing by hand. Extracted seeds were dried under fan in Laboratory for two days.

For determination of optimum

condition of storage, fruits were collected from five trees on 5th Aug., 1986 and seeds were extracted as described above. Extracted seeds were dried for four days under fan in laboratory prior to storage and moisture determination.

Observation on studies of maturity : Observation on weight, size etc. recorded in Table 1 are based on mean of four replicates of 100 fruits each. Moisture content was determined by oven dry method (105°C + for 16 hrs.) on wet basis. Internal morphological structures were observed by cutting fruits. Colour of the fruits was also recorded during each collection.

Seed storage conditions : For studies on effect of fruit maturity on seed longevity, seeds were stored in perforated polythene bags kept at room temperature For determination of optimum conditions of storage, seeds were thoroughly mixed and stored as follows :

Storage container	*Storage temperature*
Sealed polythene bag	Room temp., 15°C and 5°C
Perforated polythene bag	Room temp , 15°C and 5°C
Perforated card-board box (seeds wrapped in blotters)	Room temp., 15°C and 5°C
Over silica gel in desiccator	Room temp., 15°C and 5°C

Germination test : After every 15 days a representative sample was drawn from each storage condition and tested for germination capacity. Four replicates of 100 seeds each were taken and sown on sterilized quartz sand filled in enamelled trays. These trays were kept in a walk-in-germination room maintained at 30°C with 7 hrs light on working days. Watering was done as and when required and germination was recorded daily till final count. Seeds from which cotyledons emerged from the surface of the substratum were considered as germinated.

Mean of four replicates was taken for germination percentage and speed of germination was calculated in terms of Germination Value according to Czabator (1962).

Ambient temperature and relative humdity during the experiment

		June,'86	July,'86	Aug.'86	Sept.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb.'87
Temperature	Max.	33.7	29.9	29.9	29.6	27.3	25.3	20.3	20.7	23.0
	Min.	20.2	22.3	22.3	19.7	13.8	8.9	4.8	4.4	7.2
Relative	7 hr.	83	93	95	94	94	95	96	96	93
Humidity	14 hr	56	76	76	67	58	53	54	50	48

(Adopted from Forest Influences Branch, Forest Research Institute)

Table 1

Effect of different harvest periods on physical characteristics of A. indica fruits and seeds

Code	Collection period (weeks after flowering)	Wt. of 100 Fruits (cm)	Fruit size (cm) Length	width	Fruit Moisture (%)	Wt. of 100 Embryos (gm)	Embryo size (cm) Length	width	Embryo Moisture (%)	Soft un-extractable seeds (%)	Yellow Fruits (%)	No of Days required for pulp decomposition	Remarks
C_1	4	45 46	1.20	0.63	81.1	8 97	0 73	0.35	90.7	100	0	Seeds were not extractable even after 10 days.	Fruits soft, thickly milked, endocarp soft, transparent.
C_2	6	85.52	1.46	0.87	81.9	15.87	1.07	0.56	86.6	79	0	7	Fruits soft to firm, thickly milked, endocarp soft.
C_3	8	105.14	1.56	1.02	82.8	16.60	1.15	0.58	86.2	73	0	7	Fruits firm, thickly milked, endocarp moderately hard.
C_4	10	134.39	1.63	1.12	74.2	20 60	1.16	0.59	76.8	12	2	3	Fruits firm, thinly milked, endocarp hard.
C_5	12	143.63	1.17	1.22	69.8	21.71	1.16	0.59	71.3	0	18	2	Fruits firm, thinly milked, endocarp hard.

Results and discussion

Effect of different harvest dates on physical characteristics of fruits & seeds: Throughout development period the fruit does not change its colour and remains green to pale green. However, after ripening it turns yellow and falls on the ground. Changes in other characteristics of fruits and embryos are shown in Table 1. It is evident that fruits of *A. indica* gradually increase in size till 10-12 weeks after flowering (late July to early August) when dry matter accumulates considerably and moisture content begins to decrease. Fruits collected about one month after flowering (C_1) were completely immature with thin, transparent and soft endocarp. It was not possible to extract seeds from the fruits at this stage. However, gradually with the development of fruits the endocarp developed into a hard fibrous coat thereby making seeds readily extractable.

Effect of fruit maturity on seed longevity: Premature seeds were highly susceptible to fungal attack and rapidly deteriorated in storage. It is evident (Fig. 1) that seeds collected 6 weeks after flowering (C_2) exhibited only 16% initial germination and complete deterioration when tested after 15 days. However, germination capacity increased with the fruit development and seeds collected 8 weeks after flowering exhibited 34.5% initial germination. But this also rapidly deteriorated in storage and there was no germination when tested after 2½ months. Seeds collected 10 weeks (C_4) and 12 weeks after flowering (C_5) exhibited 82 and 85% initial germination respectively. In storage both the lots exhibited gradual deterioration in germination capacity and after 6 months gave 8 to 10% germination.

Figure 1 further indicates that physiological maturity was reached around late July to early August, when seed attained maximum germination and capacity to remain viable for longer durations. This period coincided with maximum fruit weight, fruit size, embryo weight and embryo size. Moisture content dropped sharply, endocarp became fibrous and hard and some of the seeds started yellowing during this period.

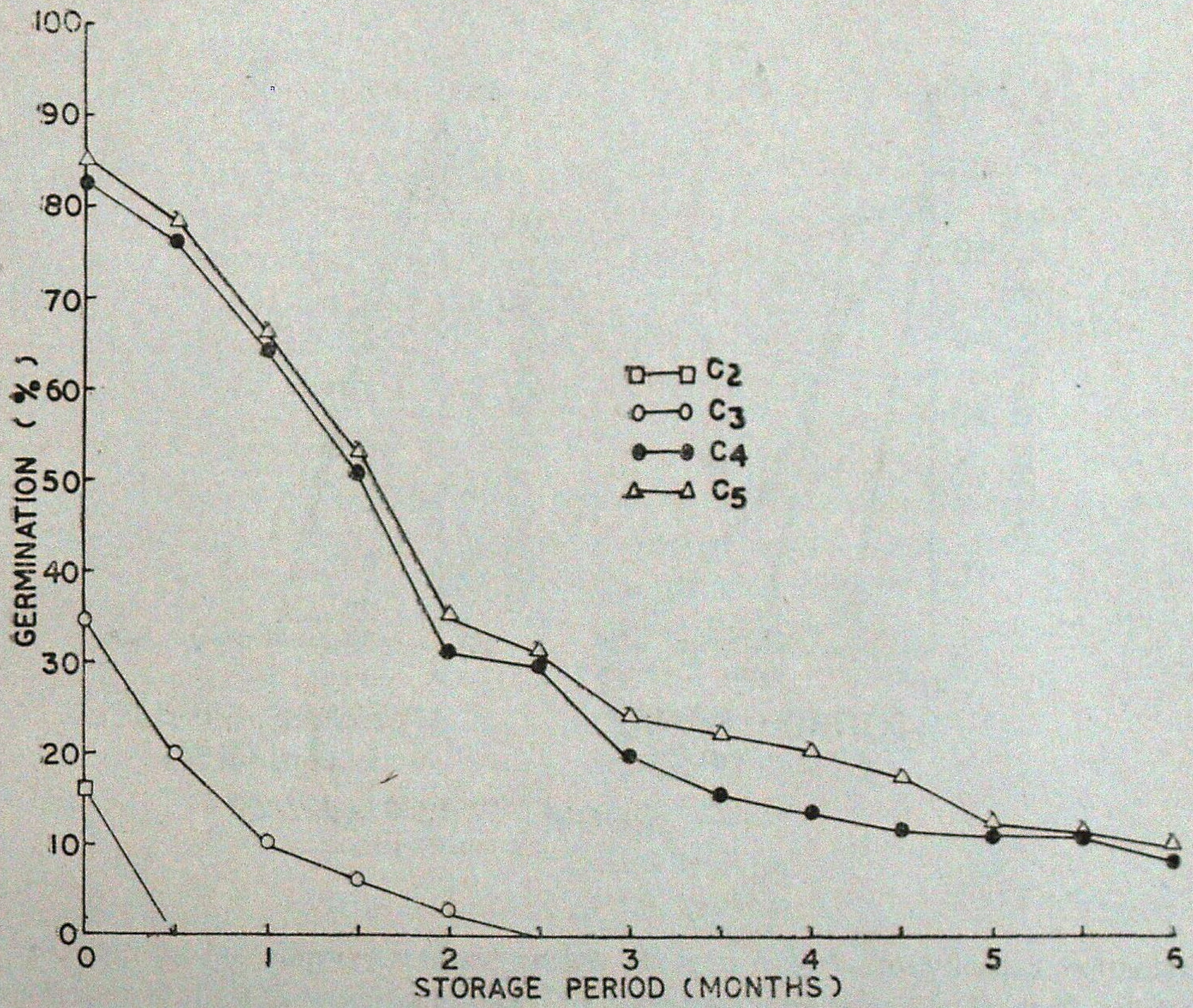
Effect of storage conditions on seed longevity: Initial germination, germination value and moisture content of the seeds were determined prior to storage and were found to be 58%, 13.67% and 37.2% respectively.

Wide range of variations in longevity of *A. indica* seeds under different storage conditions is apparent. Not only storage temperature but the type of container also influenced life span of the seeds.

Storability in sealed polythene bags: Seeds stored in sealed polythene bags exhibited much rapid deterioration in germination capacity at all the temperatures (Fig. 2). At room temperature only 4.5% germination and 0.13 germination value were obtained after 15 days storage and the seed completely lost germination capacity after one month. Seeds stored at 15°C and 5°C, however behaved differently and exhibited little drop in germination capacity after 15 days but rapidly afterwards. Seeds completely lost germination capacity within 2 months and 1½ months at 15°C and 5°C respectively.

Storability in perforated polythene bags: Seeds stored in perforated polythene bags remained viable for comparatively longer periods (Fig. 3). However, variations in

Fig. 1



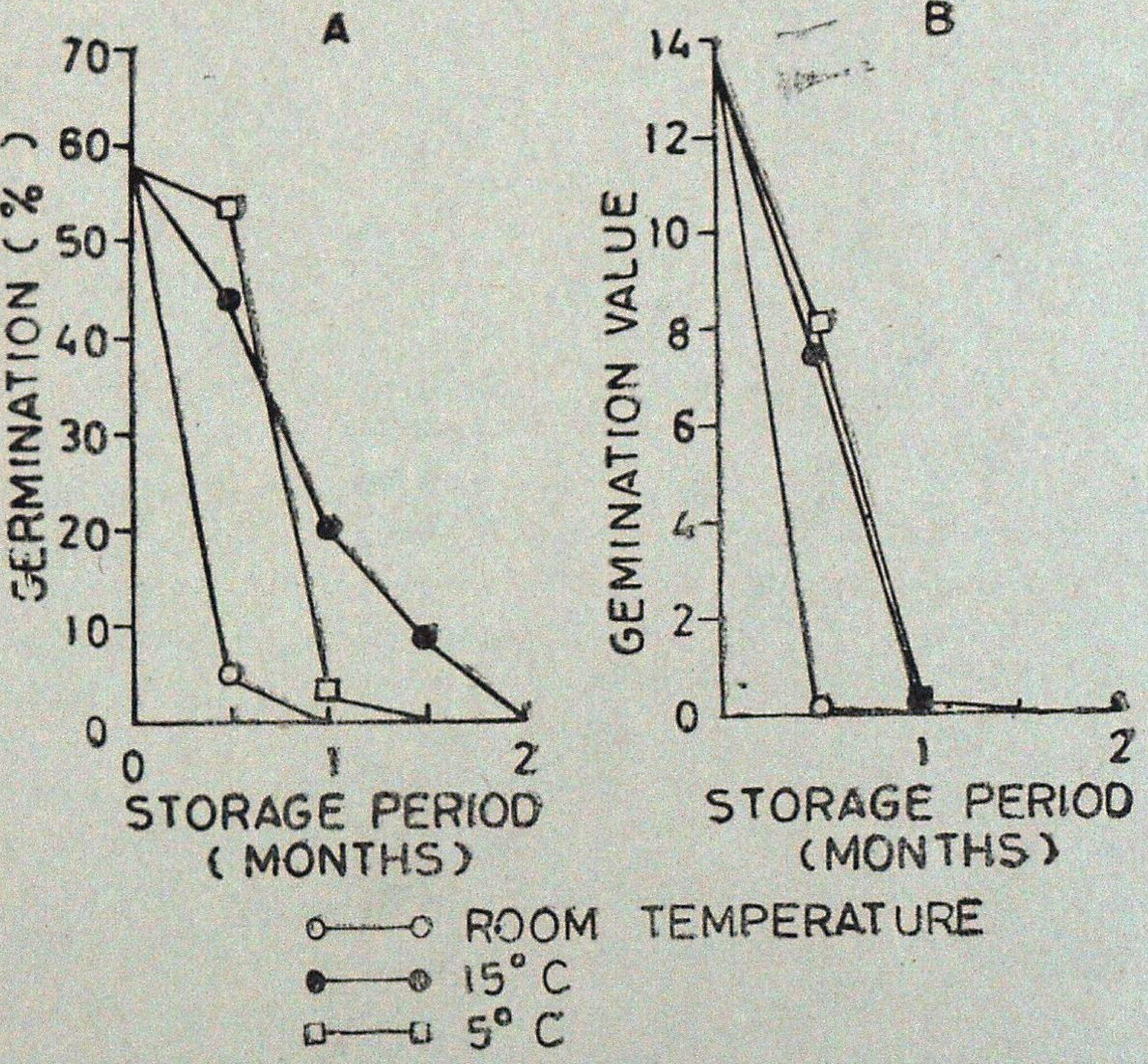
Longevity of *A. indica* seeds in perforated polythene bags at room temperature collected at different intervals of maturity.

longevity as affected by temperature are evident. Seeds stored at 5°C completely lost germination capacity within $3\frac{1}{2}$ months while seeds stored at 15°C room temperature remained viable even after 6 months exhibiting 12.0% and 11.0% germination and 0.47 and 0.29 germination value respectively.

Storability in perforated cardboard boxes (seeds wrapped in blotters) : Seeds wrapped in blotters and kept in perforated cardboard boxes also remained viable for longer periods at all the temperatures (Fig 4). Seeds at 5°C completely lost germination capacity within $3\frac{1}{2}$ months while at 15°C it took 6 months. Seeds at room temperature exhibited 6.0% germination and 0.11 germination value even after 6 months.

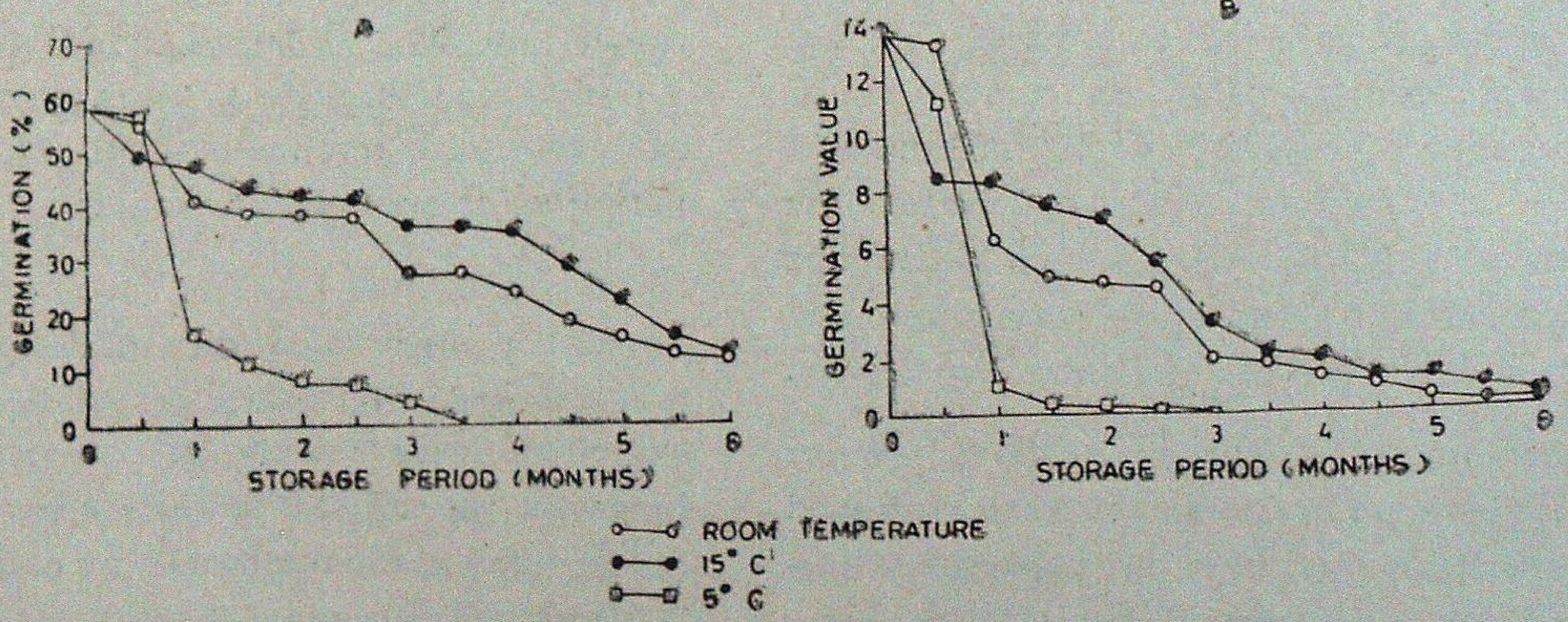
Storability over silica gel in desiccators : Seeds stored over silica gel in desiccators exhibited wide range of variations in longevity at all the temperatures (Fig. 5). Seeds stored at room temperature completely lost germination capacity within $1\frac{1}{2}$ months while it took 4 months at 15°C and $3\frac{1}{2}$ months at 5°C.

Fig. 2



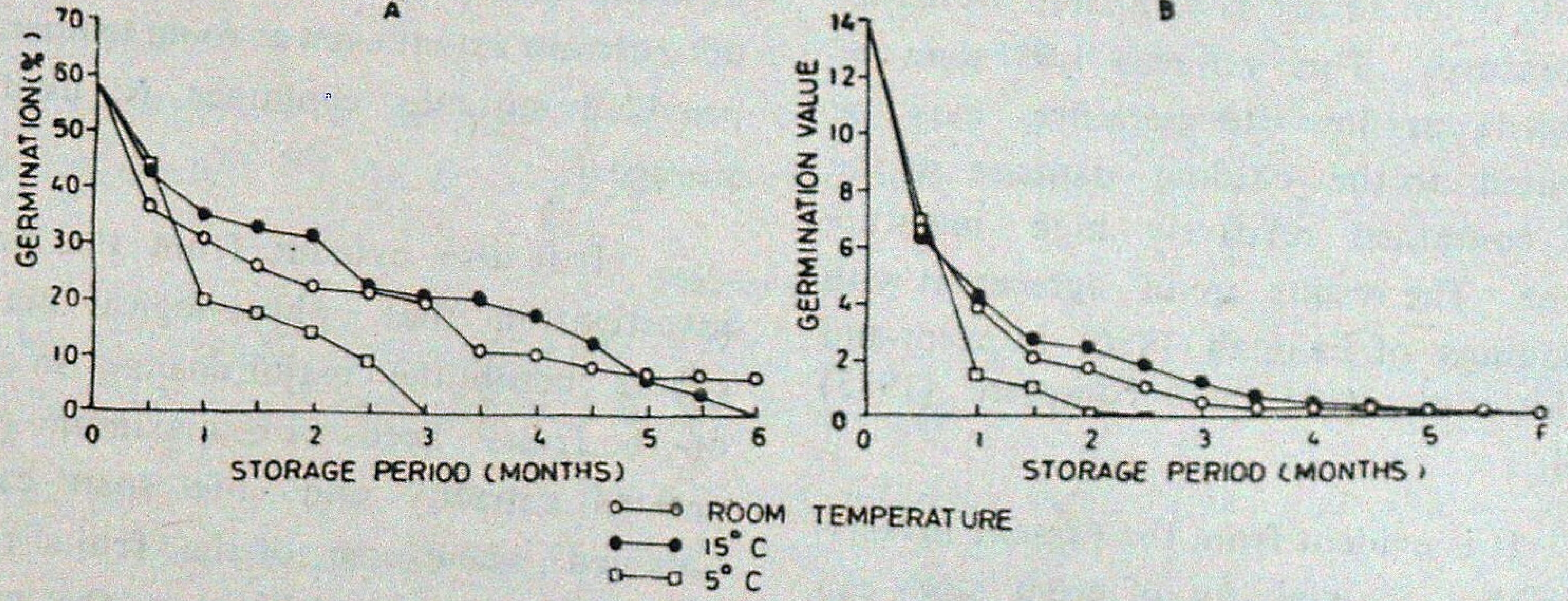
Germination capacity of *A. indica* seeds during various periods of storage in sealed Polythene bags at different temperatures. (A) Germination % and (B) Germination value.

Fig. 3



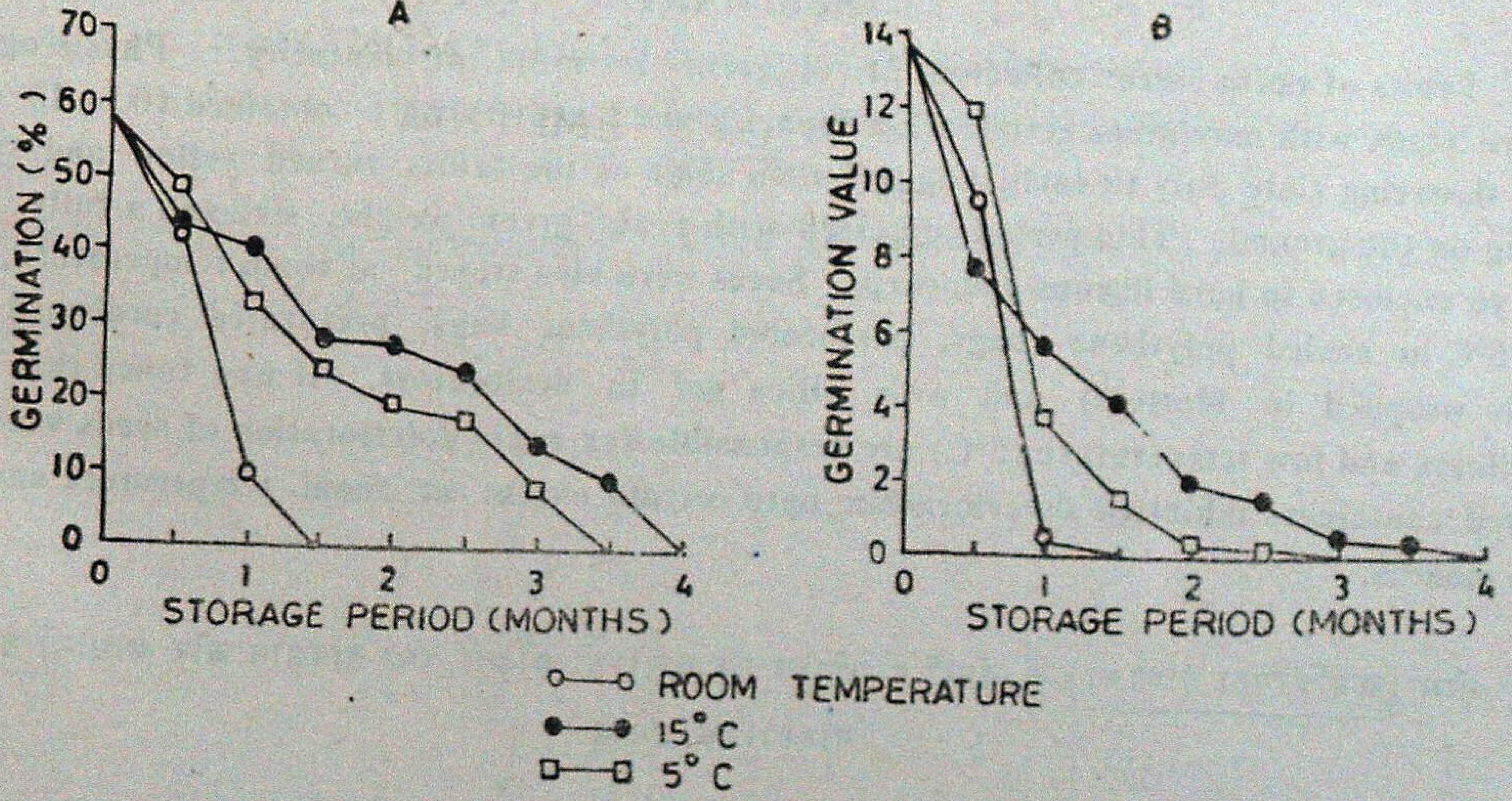
Germination capacity of *A. indica* seeds during various periods of storage in perforated Polythene bags at different temperatures. (A) Germination % and (B) Germination value.

Fig. 4



Germination capacity of *A. indica* seeds during various periods of storage in perforate cardboard boxes (seeds wrapped in blotters) at different temperatures. (A) Germination % and (B) Germination value.

Fig. 5



Germination capacity of *A. indica* seeds during various periods of storage over silica gel in desiccators at different temperatures. (A) Germination % and (B) Germination value.

The seed deteriorated much earlier in sealed containers as compared to the perforated containers at all the tested temperatures. This is probably due to the fact that seeds with relatively high moisture content require high oxygen concentration for maximum retention of viability. Perforated containers maintained the CO_2/O_2 ratio, thereby prolonging viability of the seeds.

Seeds stored at 5°C lost germination capacity much earlier as compared to higher temperatures. This reduced life span of the seeds at low temperature may be attributed to the chilling damage as the seed contained relatively high moisture content. The results are in agreement with the findings of Ezumah (1986) in neem and Purohit *et al.*, (1982) and Tompsett (1985) in sal.

It is evident from the present investigation that the viability of neem seeds can be best maintained in well aerated containers, preferably perforated polythene bags kept either at room temperature or at 15°C as both these temperatures have shown almost similar effects. Thus, deterioration in neem seeds in the field can be inhibited upto certain extent even at room temperature provided suitable container is used for storage

It is also evident from the present investigation that physiological maturity occurs before the major change in colour of the fruits. Seeds with maximum germinations capacity and life span can be obtained when some of the fruits turned yellow and started falling on the ground which is probably the best and easily detectable index of maturity and may be recommended for bulk collections.

SUMMARY

Fruits of neem were collected at different intervals of maturity. Physiologically mature seeds with maximum germination capacity and longevity were obtained 10 to 12 weeks after flowering (late July to early August) when some of the fruits turned yellow and started falling on the ground. This period coincided with peak green weight, size and a fully grown embryo enclosed in hard fibrous endocarp. Seeds were also stored at room temperature, 15°C and 5°C in sealed polythene bags, perforated polythene bags, perforated cardboard boxes (seeds wrapped in blotters) and over silica gel in desiccators. It was found that sealed containers and low temperature (5°C) are responsible for rapid deterioration of seeds while well aerated containers inhibited deterioration upto certain extent at room temperature and 15°C till 6 months.

नीम (अजेडिरेक्टा इण्डिका) के बीजों दीर्घायुष्य पर फलों की प्रौढ़ता तथा तापमान और आधानों का पारस्परिक प्रभाव

जी०पी० मैठाणी, वी०के० बहुगुणा, एम०एस० रावत व ओ०पी० सूद

सारांश

प्रौढ़ता की विभिन्न अवस्थाओं पर निबोलियाँ एकत्रित की गई। देह-व्यापार की दृष्टि से प्रौढ़ बीज, जिनकी अंकुरण क्षमता अधिकतम और दीर्घायुष्य अधिकतम रहा, वे थे जो पुष्पन (जुलाई अंतिम से अगस्त प्रारम्भ) के 10-12 सप्ताह बाद एकत्र किए गए जब कुछ फल पीले हो गए और टपक कर भूमि पर गिरने लगे। इसी समय उनका हरा भार, आकार शिखर पर पाया गया तथा कड़ी रेशेदार अन्तर्भित्ति से लिपटा पूर्ण विकसित

भ्रूण उसके भीतर था । ये बीज कमरे के तापमान 15° से० व 5° से० पर मुहरबन्द पोलीथीन थैलियों, छिद्रित पोलीथीन थैलियों, छिद्रित गत्ते के बक्सों (बीजो को ब्लोटिंग कागज मे लपेटकर) तथा शोष्यक मे सिलिका जेल पर रखकर भण्डारित किए गए । इससे पाया गया कि बीजों के तीव्र गति से विघटन होने के लिए मुहरबन्द आधान और कम तापमान (5° से०) जिम्मेदार हैं और भली-भांति हवा लगते रहना, कमरे के तापमान पर रखने पर कुछ सीमा तक और 15° से० पर 6 महिनों तक बीजों को सड़ने से रोकता है ।

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RECOVERY OF SCANTLINGS FROM *EUCALYPTUS* LOGS–II

S.K. KAPUR* AND B.N. GUPTA**

Introduction

In Punjab, eucalypt timber is mostly used for manufacturing wooden pallets, and gratings for storage of bags containing food grains, cement, sugar, fertilizers etc. 5 scantlings of 152.4 cm × 6.35 cm × 5. 08 cm size and 5 of 91.44 cm × 10.16 cm × 5 08 cm dimension are used in fabrication of one pallet. The results of sawing of eucalypt logs into scantlings of 6.35 cm × 5.08 cm cross section have already been published (Kapur & Gupta, 1986). This paper presents the results of sawing of eucalypt logs of various girth classes into scantlings of 10.16 cm × 5.08 cm cross section.

Material and Method

Freshly cut straight *Eucalyptus tereticornis* logs of the desired length brought from forests were graded into 10 cm girth (over-bark) classes viz; 40-49 cm (G1), 50-59 cm (G2), 60-69 cm (G3), 70-79 cm (G4), 80-89 cm (G5), 90-99 cm (G6), 100-109 cm (G7), 110-119 cm (G8), 120-129 cm (G9), 130-139 cm (G10) and 140-149 cm (G11). Volume of each log was worked out with quarter girth formula. These were sawn at vertical band saw mills of the Punjab State Forest Development Corporation Ltd. at Bhatinda, Mansa, Phillaur and Sadeq which are provided with 19 gauge thick and 6.35 cm wide saw blades into scantlings of 10.16 cm × 5. 08 cm cross section. Number of scantlings obtained from each log was noted, their volume determined by actual geometrical formula and percentage of volume of sawn scantlings to the volume of round logs (determined according to quarter girth formula) was worked out. Data was subjected to statistical analysis.

Result and Discussion

The result of sawing along with necessary calculations are furnished in Appendix 1. Mean along with S.D. of observations are given in Table 1.

Two important aspects of the study are discussed below :

1. *Number of scantlings per m³ of round log* : Number of scantlings obtainable from sawing of each m³ of logs of different girths is presented in Appendix I (mean given in Table 1). Analysis of variance (Table 2) indicated that significantly different number of scantlings are obtained from logs of various girth classes.

It suggests that eucalypt logs should be graded into 40-99 cm and 100-149 cm girth classes for estimating the recovery of scantlings of 10.16 cm × 5.08 cm cross section.

2. *Recovery per cent of sawn timber from round logs* : Recovery of sawn timber from round logs expressed as percentage is shown

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Table 1

Scantlings of 10.16 cm × 5.08 cm cross section (mean alongwith S.D.) recoverable from *logs of different girth classes.*

Girth class	Girth (Overbark) (cm)	Mean girthof logs (cm)	Vol. (m^3)	No. of scant-lings	Sawn Vol. (m^3)	No. of scant-lings per m^3 of round timber	Sawn recovery percentage (%)
G1	40-49	44.77 (3.39)	0.012 (0.002)	1.62 (0.50)	0 008 (0.002)	135 88 (30.24)	63 80 (14.21)
G2	50-59	54.19 (2.59)	0.017 (0 002)	2.25 (0.45)	0.010 (0.003)	129 22 (18.85)	60.74 (8 85)
G3	60-69	64.06 (2.36)	0.024 (0.002)	3.29 (0.69)	0.016 (0.003)	134.23 (20.32)	65.29 (11.98)
G4	70-79	73.48 (2.73)	0.032 (0.003)	4 26 (0 55)	0.020 (0.003)	132.09 (11.43)	62.80 (5.43)
G5	80-89	83 06 (2.22)	0 041 (0.002)	5.71 (0.59)	0 027 (0.002)	138.68 (5.02)	65 37 (2.60)
G6	90-99	93 11 (1.76)	0 051 (0.002)	7.11 (0.33)	0.034 (0.002)	138.59 (5.02)	64.38 (2.60)
G7	100-109	103.22 (3 07)	0.063 (0.004)	9.78 (0.83)	0 046 (0.004)	154.52 (6.31)	72.51 (3.27)
G8	110-119	116 17 (1.33)	0.080 (0 002)	12 33 (0 52)	0 058 (0 003)	155.11 (4.71)	72 22 (2.07)
G9	120-129	123.60 (2.41)	0 091 (0.003)	14.20 (1.10)	0 067 (0.005)	156.20 (6.22)	73.66 (3.27)
G10	130-139	136 00 (1.41)	0.110 (0.002)	16 20 (0.83)	0 076 (0 004)	147.76 (5.37)	69.50 (2.39)
G11	140-149	141.00 (0.00)	0.118 (0.00)	17.50 (0 71)	0 083 (0.004)	148.31 (5 99)	69.90 (2.97)

in Appendix 1; mean presented in Table 1. The analysis of variance of data (Table 3) brought out that the performance of different girth classes is significantly different.

Study of this parameter again indicates the classification of eucalypt logs into 40-99 cm and 100-149 cm girth classes for obtaining scantlings of 10 16 cm × 5.08 cm cross section.

Table 2

Analysis of variance of number of scantlings per m³ of round timber

Source of Variation	Sum of Squares	Degrees of freedom	Mean square of variance	F-Ratio of mean squares	Snedocor's F Value P=0.05	Signi-ficance
Between girth classes	9310 36	10	931.036	3 59	1.91	*
Within girth classes	28814.16	111	259.587			
Total	38124.52	121				

The test resulted in the following bar diagram

G1	G2	G3	G4	G5	G6
135.88	129.22	134.23	132.09	138.68	138.59

G7	G8	G9	G10	G11
154.52	155.11	156.20	147.76	148 31

Table 3

Analysis of variance of sawn recovery %

Source of Variation	Sum of squares	Degrees of freedom	Mean square of variance	F-Ratio of mean squares	Snedocor's F Value P=0.05	Signi-ficance
Between girth classes	1786.77	10	178.677	3.02	1.91	*
Within girth classes	6574.38	111	59.23			
Total	8361.15	121				

The t-test gave rise to the following bar diagram ;

G1	G2	G3	G4	G5	G6
63.8	60 74	65.29	62.80	65.37	64.38

G7	G8	G9	G10	G11
72.51	72.22	73.66	69.50	69.90

Appendix-I

Recovery of scantlings of 10.16 cm × 5.08 cm cross section from Eucalyptus tereticornis logs of different girth classes.

Girth (O.B.) class (cm)	Girth (O.B.) (cm)	Vol. (m^3)	No. of scantlings	Sawn Vol. (m^3)	No. of scantlings per m^3 of round timber	Sawn recovery (%)
1	2	3	4	5	6	7
40–49	40	0.009	1	0.0047	111.11	52.2
	40	0.009	1	0.0047	111.11	52.2
	41	0.010	1	0.0047	100.00	47.0
	42	0.010	1	0.0047	100.00	47.0
	43	0.010	1	0.0047	90.91	42.7
	44	0.011	2	0.0094	181.82	85.5
	45	0.012	2	0.0094	166.67	78.3
	46	0.012	2	0.0094	166.67	78.3
	46	0.012	2	0.0094	166.67	78.3
	48	0.014	2	0.0094	142.86	67.1
	49	0.014	2	0.0094	142.86	67.1
	49	0.014	2	0.0094	142.86	67.1
	49	0.014	2	0.0094	142.86	67.1
50–59	50	0.015	2	0.0094	133.33	62.7
	51	0.015	2	0.0094	133.33	62.7
	51	0.015	2	0.0094	133.33	62.7
	52	0.016	2	0.0094	125.00	58.8
	52	0.016	2	0.0094	125.00	58.8
	53	0.017	2	0.0094	117.65	55.3
	54	0.017	2	0.0094	117.65	55.3
	54	0.017	2	0.0094	117.65	55.3
	54	0.017	2	0.0094	117.65	55.3
	55	0.018	3	0.0141	166.67	78.3
	55	0.018	2	0.0094	111.11	52.2
	56	0.019	2	0.0094	105.26	49.5
	57	0.019	3	0.0141	157.90	74.2
	57	0.019	2	0.0094	105.26	49.5
	57	0.019	3	0.0141	157.90	74.2
	59	0.021	3	0.0141	142.86	67.1

(Contd...)

1	2	3	4	5	6	7
60–69	61	0.022	3	0.0141	136 36	64.1
	61	0.022	2	0.0094	90.91	43.0
	62	0.023	2	0.0094	90.91	41.0
	62	0.023	3	0.0141	130 44	61 3
	62	0.023	3	0.0141	130.44	61.3
	62	0.023	3	0.0141	130.44	61.3
	62	0.023	3	0 0141	130.44	61.3
	63	0.023	3	0.0141	130.44	61.3
	64	0.024	3	0 0141	125.00	58.8
	65	0.025	3	0.0141	120.00	56.0
	65	0.025	4	0.019	160 00	76.0
	65	0.025	4	0.019	160.00	76.0
	66	0.026	4	0.019	153.85	77.7
	67	0.027	4	0.019	148.15	77.7
	67	0.027	4	0.019	148.15	77.7
	67	0.027	4	0.019	148.15	77.7
	68	0.027	4	0.019	148.15	77.7
70–79	70	0 029	4	0.019	137.93	65.5
	70	0.029	4	0.019	137.93	65.5
	70	0.029	4	0.019	137.93	65.5
	71	0.030	4	0.019	133.33	63.3
	71	0.030	4	0.019	133.33	63.3
	71	0.030	4	0.019	133.33	63.3
	71	0.030	4	0 019	133.33	63.3
	71	0 030	4	0.019	133.33	63.3
	71	0.030	4	0.019	133.33	63.3
	72	0.031	5	0.024	161.29	77.4
	73	0 032	4	0.019	125.00	59.4
	73	0.032	4	0.019	125.00	59.4
	75	0.033	4	0.019	121.21	57.6
	75	0.033	4	0.019	121.21	57.6
	75	0.033	4	0.019	121.21	57.6
	75	0.033	4	0.019	121.21	57.6
	75	0.033	4	0.019	121.21	57.6
	75	0.033	4	0.019	121.21	57.6
	76	0.034	5	0.024	147.06	70.6
	76	0.034	4	0.019	117.65	55.9
	78	0.038	6	0.028	157.90	73.7
	78	0.038	5	0.024	131.60	63.2
	78	0.038	5	0.024	131.60	63.2

1	2	3	4	5	6	7
80–89	80	0.038	5	0.024	131.58	63.2
	80	0.038	5	0.024	131.58	63.2
	80	0.038	5	0.024	131.58	63.2
	81	0.039	5	0.024	128.21	61.5
	81	0.039	5	0.024	128.21	61.5
	81	0.039	5	0.024	128.21	61.5
	83	0.041	6	0.028	146.34	68.3
	83	0.041	6	0.028	146.34	68.3
	83	0.041	6	0.028	146.34	68.3
	84	0.042	6	0.028	142.86	66.7
	84	0.042	6	0.028	142.86	66.7
	84	0.042	6	0.028	142.86	66.7
	85	0.043	6	0.028	139.54	65.1
	85	0.043	6	0.028	139.54	65.1
	85	0.043	6	0.028	139.54	65.1
	86	0.044	6	0.028	139.36	63.6
	87	0.045	7	0.033	155.56	73.3
90–99	91	0.049	7	0.033	142.86	67.3
	91	0.049	7	0.033	142.86	67.3
	92	0.050	7	0.033	140.00	66.0
	92	0.050	7	0.033	140.00	66.0
	93	0.051	7	0.033	137.26	64.7
	94	0.052	7	0.033	134.62	63.5
	94	0.052	7	0.033	134.62	63.5
	95	0.054	7	0.033	129.63	61.1
	96	0.055	8	0.038	145.46	60.0
100–109	100	0.059	9	0.042	152.54	71.2
	100	0.059	9	0.042	152.54	71.2
	101	0.061	9	0.042	147.54	68.9
	102	0.062	10	0.047	161.29	75.8
	103	0.063	10	0.047	158.73	74.6
	103	0.063	9	0.042	142.86	66.7
	104	0.064	10	0.047	156.25	73.4
	107	0.068	11	0.052	161.77	76.5
	109	0.070	11	0.052	157.14	74.3

(*Contd...*)

1	2	3	4	5	6	7
110–119	115	0.078	12	0.056	153.85	71 8
	115	0 078	12	0.056	153 85	71.8
	115	0.078	12	0 056	153 85	71 8
	117	0.081	12	0.056	148.15	69.1
	117	0 081	13	0 061	160.49	75 3
	118	0.083	13	0.061	160 49	73.5
120–129	121	0.087	13	0.061	149.43	70.1
	121	0.087	13	0.061	149.43	70.1
	125	0.093	15	0.071	161.29	76.3
	125	0.093	15	0 071	161.29	76 3
	126	0.094	15	0 071	159.57	75.5
130–139	135	0.108	15	0.071	138.89	65.7
	135	0.108	16	0.075	148 15	69.4
	135	0.108	16	0.075	148 15	69.4
	137	0.111	17	0 080	153.15	72.1
	138	0.113	17	0 080	150 44	70.8
140–149	141	0.118	17	0.080	144.07	67.8
	141	0.118	18	0.085	152.54	72.0

Conclusion

The above results bring out that eucalypt logs should be graded into 40-99 cm and 100-149 cm girth classes in case the object is to obtain scantlings of 10.16 cm × 5.08 cm cross section.

Acknowledgement

Assistance in collection of data by Shri Harbhajan Singh, Sectional Officer, P.S.F.D.C., is acknowledged.

SUMMARY

Study was carried out on the recovery of sawn scantlings of 10.16 cm × 5.08 cm cross section from *Eucalyptus tereticornis* logs of different girth classes. It was inferred that for this purpose, the logs should be classified into 40-99 cm and 100-149 cm girth classes.

युकेलिप्टस के लट्ठों से कड़ियां निकालना—II

एस॰के॰ कपूर व बी॰एन॰ गुप्त

सारांश

युकेलिप्टस टेरिटिकार्निस के विभिन्न गोलाई वर्गों के लट्ठों से 10.16 सेमी॰ × 5.08 सेमी॰ नाप की चिरान की हुई कड़ियां निकालने का एक अध्ययन किया गया। परिणाम यह निकला कि इस प्रयोजन के लिए लट्ठों को 40-99 सेमी॰ और 100-149 सेमी॰ गोलाई वर्गों में वर्गीकृत किया जाना चाहिए।

Reference

Kapur, S.K. and B.N. Gupta (1986). Recovery of scantlings from *Eucalyptus* logs, *Indian For.*, **112** (6) : 491-502.

BARK CONTENT OF A MATURE EUCALYPTS TREE

J.K. RAWAT*

Introduction

It is important to know the bark content of a tree for two main reasons. First, the girth or diameter measurements are usually made overbark while the usable products, such as timber and pulpwood, need to be quantified without bark. Second, the bark is one of the principal constituents of the above-ground biomass obtained from a tree and it is often a source of several useful chemicals and other products.

In this paper, local bark volume table for mature (8 to 10 years old) *Eucalyptus* hybrid is estimated from the data collected from North Haryana. The volume of bark is computed for the whole tree as well as for the timber† produced by the tree. In the process, a technique has been developed for estimating bark volume for straight growing tree species.

Methodology and Data

Estimates of bark volume of *Eucalyptus* hybrid have been mentioned in F.A.O. (1981) which have been derived from Chaturvedi (1973). This bark content has been computed indirectly as a difference between overbark and underbark volumes of a tree. Values obtained as difference of two regression equations are not likely to represent the desired variable accurately. In this paper, the volume of bark is estimated directly from measurement of bark thicknesses, and subsequently its relationship with the size of the tree has been estimated to generate the bark volume table.

The data used in this study were collected from three different sites in Haryana where eucalypts plantations of 8 to 10 years of age were being harvested : viz. a canal strip in Sonepat district, a road strip in Karnal district and a compact forest area in Kurukshetra district.

Girths overbark (G) and underbark (GUB) were measured at various heights along a tree and on different trees. The data revealed a very high degree of correlation between G and GUB, which meant that the bark thickness at any cross section was strongly related to the girth at that cross section (Husch, 1963). Hence, if the girths at various heights of a tree is known, the corresponding bark thicknesses can be easily estimated. Eucalypts being a fairly straight growing tree, the form of its main stem can be approximated to a "cone". Consequently, the bark thickness profile of a tree of a given girth at breast height can be easily drawn. The infinitisimal volume of bark at a

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† Stem portion of a tree above a certain girth generally constitutes timber.

particular cross section can then be written as a function of height. Its integration for the total height of the tree would give the volume of bark for the complete "conical" stem. When the bark content of only the timber portion of the tree is to be estimated, the integration is done merely over the appropriate length of the tree. However, since the tree form is not exactly conical and the whole tree includes branches as well, a correction will have to be applied to get a more accurate estimation of bark volume. The correction, described as "conical form factor" (Husch, 1963), is the ratio of volume of the whole tree to the volume of the "cone".

A totalof 238 observations of over-bark under-bark girths were made. In practice, stems over 60 cm girth are treated as timber in Haryana. Lengths of timber bole and the corresponding girths at breast height of the trees were recorded, and 105 such observations were made. All these observations were well spread over different girth classes and the three sites.

Analysis and Results

Given a conical body, girth Gx (meters) of a section at a height x (meters) from the base of the cut stem is given by :

(i) $Gx = G\,(h-x)/(h-B)$,

where h (meters) is the total height of the tree less the stump height, B is the breast height (1.37 m) less the stump height and G (meters) is the overbark girth at breast height. If the bark thickness at x is Thx, the volume of an infinitisimal width dx of bark at x will be given by :

(2) $dVB = Gx\ Thx\ dx$.

Integration of dVB over appropriate lengths would give the desired bark volumes.

The variation in bark thickness with girths is derived from the following linear equation between G and GUB (meters) obtained from the data ("df" represents the degrees of freedom) :

(3) $GUB = 0.01 + 0.88447\,G$ ... ($R^2 = 0.99$; df $= 236$).

The bark thickness (meters) at x meter is then given by :

(4) $Thx = 0.0183823\,Gx - 0.001592$.

Substituting for Gx and Thx in (2) and integrating from 0 to h meters gives the following expression for the bark volume VB (in m^3) :

(5) $$VB = \left(0.000796\frac{G\,h^2}{h-B}\right) \times \left(7.702\frac{G\,h}{h-B} - 1\right).$$

The average stump height, based on the field observations is nearly 0.07 m This gives B = 1.30 m and, if H is the total height of the tree in meters, h = H—0.07. In order to estimate bark volume from only girth measurement we need to determine a relationship between H and G for which a total of 160 observations were recorded. However, no simple relationship seems to exist between these two attributes of a tree and the best linear regression equation that could be obtained from the given data is shown below :

(6) $H = 21.4216 + 3.84546 \log (B)$ ......($R^2 = 0.33$; df $= 158$).

A low value of R^2 for the regression above indicates that the girth of a tree is not enough to explain most of the variation

in tree heights. Local conditions and genetic attributes may be other determining factors.

A similar relationship (7) was obtained between G and TB, the length of timber bole in meters The degree of fit in this case is much better as indicated by a higher value of R^2.

(7) $TB = 9.30902 + 13.34232 \log (G)$
$\ldots\ldots(R^2 = 0.77;\ df = 103)$.

The above equation is, of course, valid only of trees with $G \geqslant 60$ cm, i.e., for trees producing timber. In this case, the expression for Gx in terms of G, x and TB is given by :

(8) $Gx = 0.6 + (G-0.6)\ (TB-x)/(TB-B)$

Substitution of (8) and (4) in (2) gives a modified expression for dVB. Its integration from 0 to TB produces the following formula for VBT, the bark volume (in m^3) for the timber portion of the tree :

(9) $VBT = TB\ (0.0056627 + 0.0102336\ Z + 0.0061274\ Z^2)$,

where $Z = TB\ (G - 0.6)\ /\ (TB - B)$.

Now VB and VBT can be easily computed for a eucalypts tree of a given size. A correction has now to be applied to VB and VBT to take care of the actual form of the tree and volume of wood outside the main stem. A relationship between actual overbark volume of tree (VOB) and G, and similarly between overbark volume of timber (TOB) and G, given below, have been estimated for North Haryana (Rawat, 1988) :

(10) $\sqrt{VOB} = -0.186961 + 1.10826\ G$
$\ldots(R^2 = 0.91;\ df = 182)$.

(11) $\sqrt{TOB} = -0.377297 + 1.08272\ G$
$\ldots(R^2 = 0.92;\ df = 182)$.

The bark volumes estimated from equations 5 and 9 were corrected using the "conical form factor" (Husch, 1963). The corresponding corrected volumes of bark VB and VBT respectively, are as given in the following table. It also shows the bark content as percentage of the overbark volume.

Bark Volume Table

G (cm)	H (m)	TB (m)	VOB (m^3)	corrected VB (m^3)	of VOB (%)	TOB (m^3)	corrected VBT (m^3)	of TOB (%)
30	16.8	0	0.0212	0.0029	13.7	—	—	—
45	18.4	0	0.0972	0.0164	16.9	—	—	—
60	19.5	2.2	0.2285	0.0419	18.3	0 0742	0.0146	19.7
75	20.3	5.2	0 4150	0.0802	19.3	0.1890	0 0393	20 8
90	21.0	7.6	0.6569	0.1308	19.9	0.3566	0 0784	22 0
105	21.6	9.7	0.9540	0.1938	20.3	0.5769	0.1346	23.3
120	22.1	11.5	1.3063	0.2706	20.7	0.8500	0 2102	24.7
135	22.6	13.0	1.7140	0.3581	20.9	1.1759	0.3078	26 2
150	23.0	14.5	2.1769	0.4599	21.1	1.5545	0.4310	27.7

Discussions

From the Table above we find that bark constitutes a significant proportion of a tree. Trees with girth over 75 cm have an average of 20 to 21 per cent of their overbark volume as bark. This fraction is somewhat lower for smaller trees. The bark content of a eucalypts tree appears to stabilize at 21 per cent for big sized trees. The table also shows that the proportion of bark on the timber produced by trees over 75 cm girth exceeds 22 per cent. The proportion of bark is almost 28 per cent for a tree of girth 150 cm.

In absolute terms also the volume of bark is quite substantial. It is interesting to note that the bark volume of a tree of girth "G" is more than the total volume of a fairly mature tree of girth "G/2". For instance, VB for G = 90 cm is greater than VOB for G = 45 cm; and VB for G = 120 cm is greater than VOB for G = 60 cm.

These data will be of use in planning utilization of bark and in mensuration studies of *Eucalyptus* hybrid. The methodology developed and employed in this paper can also be used for estimating bark content of other straight growing trees such as poplars and conifers.

SUMMARY

Bark volume table for the whole tree and for the timber produced by the tree have been presented for mature (8 to 10 years old) *Eucalyptus* hybrid in North Haryana. Bark is found to constitute nearly one-fifth of the overbark volume of a tree. If only the timber portion of the tree is considered, the bark content for trees of over 100 cm girth is more than 23 per cent.

प्रौढ़ युकेलिप्टस वृक्ष की छाल का परिमाण

जे० के० रावत

सारांश

उत्तरी हरियाणा के युकेलिप्टस हाइब्रिड के प्रौढ़ (8 से 10 वर्ष के) वृक्षों की पूरे वृक्ष की और उसके प्रकाण्ठ की छाल आयतन सारणियां इस अभिपत्र में दी गई हैं। छाल पूरे वृक्ष के सवल्क आयतन का लगभग पांचवा भाग होती है। यदि वृक्ष के केवल प्रकाण्ठ भाग को विचारार्थ लिया जाए तो वृक्षों की छाल 100 सेमी० से अधिक गोलाई वाले वृक्ष में उसके आयतन का 23 प्रतिशत से अधिक होती है।

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RECRUITMENT OF EAST HIMALAYAN OAK (*QUERCUS SERRATA*) IN WESTERN HIMALAYA

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Introduction

Forests of *Quercus leuchotrichophora* (*Q. incana*), *Q. lanuginosa*, *Q. floribunda* (*Q. dilatata*), *Q. glauca*, *Q. ilex*, and *Q. semecarpifo ia* are found in Western and Central Himalaya (Singh & Singh, 1987). However, due to heavy pollarding and extremely poor regeneration of these species, oak forest cover is increasingly declining in Jammu and Kashmir, Himachal Pradesh, and Western Uttar Pradesh.

Oak trees can be cultivated either by direct sowing (dibbling) or by transplanting from the nursery. An exotic species (*Q. pedunculata*) is cultivated in Kashmir Valley but its growth data has not been reported so far. Other exotic species such as *Q. palustris*, *Q. rubra* and *Q. cerris* are also cultivated in an arboretum at Manali.

The recruitment of a fast growing species, *Q. serrata* Thunb. of North-eastern India in North-west Sub-Himalayan region at different locations in Himachal Pradesh is reported here.

Material and Methods

Seeds of *Quercus serrata* Thunb. are procured by this Institute each year since 1980 from Manipur. In 1982 alone, 13 quintals of seeds were procured and the seedlings were raised (Pandey *et al.*, 1986) at different nurseries in collaboration of Himachal Pradesh Forest Department and Indo-German Dholadhar Project, Palampur.

Growth determination: Growth in field was recorded by the measurements of tree height and diameter according to Assmann (1970) at 4 years of age at nine locations fixed randomly. At each place 50 trees were measured in centimeters and mean values of shoot height and diameter were statistically analysed.

Study area: In Western Himalaya, Himachal Pradesh (32°22′40″—33°12′40″ N and 75°47′55″—79°04′20″ E) is a hilly and a mountainous tract with altitudes ranging from about 450 m to 6500 m above mean sea level. There is much diversification in climatic conditions due to variation in elevation and aspect. The rainfall varies from about 915 mm at Kulu to over 3400 mm at Dharamsala. At Palampur the mean maximum temperature in the area varies between 13.7°C (January) and 30.0°C (June), and the mean minimum between 8°C (January) and 25.3°C (July).

Results and Discussion

In the nursery, nearly 180 *Quercus serrata* seedlings were found growing satisfactorily from each kilogram containing 300 alive seeds. Average germination was

Fig. 1

Four years old plantation of *Quercus serrata* at Kanwadi (Palampur) in Himachal Pradesh.

Fig. 2

Close view of a 4 year old *Quercus serrata* tree.

observed to be nearly 60%. The ungerminated seeds were found to be infected by weevil larvae.

Seeds sown during March attained total seedling length of nearly 40 cm within 90 days of growth. The transplantation of tube seedlings carried during winter showed around 58% survival in Gram Panchayat land at Bir. Transplantations of naked seedlings uprooted from nursery bed showed relatively poor survival (28%) at Bir.

A dibbling experiment had shown that direct sowing of *Q. serrata* seed can be carried only in moist soil in cool situations between 1100-1600 m ASL. Direct sowing of seeds in hot dry slopes below 1000 m ASL resulted in considerable failure.

The average shoot height and diameter attained by *Q. serrata* seedlings at different locations is summarized in Table 1. At these locations, *Q serrata* seedlings reached saplings stage within 4 years and almost all the young trees showed a definite crown.

Best growth was seen at elevation between 790-1140 m above mean sea level, where the seedlings were observed to be of more than two metres height. This increased growth may be attributed to relatively warm climate prevalent in low altitude areas.

Table 1

Shoot growth of Quercus serrata Thunb. *in Western Himalaya* (*Himachal Pradesh*) *at 4 years of age.*

Forest range	Altitude (m ASL)	Height (cm)	Diameter (cm)
Shahpur	823	246 ± 0.26	18 ± 0.19
Palampur	1140	234 ± 0.41	17 ± 0.33
Ahju	1220	158 ± 0.50	10 ± 0.38
Bir	1670	151 ± 0.27	11 ± 0.51
Chauntra	1250	155 ± 0.50	10 ± 0.48
Joginder Nagar	1220	153 ± 0.44	11 ± 0.39
Mandi	790	279 ± 0.16	21 ± 0.26
Kulu	1280	208 ± 0.49	13 ± 0.28
Manali	1950	154 ± 0.51	11 ± 0.43

Values are expressed as mean ± S.E.

The results of this study further show that the soil and topography factors at elevation between 790-1950 m ASL in Himachal Pradesh (Western Himalayas) are favourable for the growth of East Himalayan *Q. serrata*. Moreover, growth and germination capacity of endemic species such as *Q. leuchotrichophora* (*Q. incana*) has been reported to be very poor (Troup, 1921; Champion & Seth, 1968; Rao *et al.*, 1986).

Since *Q. serrata* is a fast growing oak, we expect that this will produce large biomassess in the suitable zones. Its wood is brown in colour, very hard (wt. 928 kg/m³) and the broad rays give a conspicuous silver grain in radial section. It is used in North-eastern India for house building and for fuel.

Unlike evergreen West Himalayan oak species, *Q. serrata* is a deciduous species, in East Himalaya. But in Himachal Pradesh, the foliage in its brownish form is carried through winter and old leaves are discarded only at the onset of spring. However, the nutritive value of *Q. serrata* leaves as fodder remains to be studied in H.P.

Young leaves of *Q. serrata* may also be employed for feeding tasar silkworms in Himachal Pradesh as in Manipur, this practice provide gainful remunerative avocation to the weaker down-trodden section of the hills.

Acknowledgements

We thank Director, C.T.R. & T.I., Ranchi for providing necessary facilities. Thanks are also due to Shri D.P. Gupta, Conservator of Forests, Shimla and to Shri O.P. Sharma, Divisional Forest Officer, Dharamsala for their interest and encouragement.

SUMMARY

North-east Himalayan Oak, *Quercus serrata* Thunb. was introduced in Western Himalayas at different locations in Himachal Pradesh. At 4 years of age, average shoot height was observed to be between 151-279 cm with 10-21 cm diameter. Considerable variation in growth rate was evident between different locations, which was due to differences in altitude. Low altitude areas (790-1140 m ASL) were found to be more suitable for the recruitment of *Q. serrata* in Himachal Pradesh.

पश्चिमी हिमालय क्षेत्र में पूर्वी हिमालय क्षेत्र का बांज वृक्ष (क्वेरक्स सेर्राटा) लगाना

आर०के० बहल व आर०के० पाण्डेय

सारांश

पूर्वोत्तर हिमालय के बांज, क्वेरक्स सेर्राटा थुनब०, को हिमालय प्रदेश के कई स्थानों पर पश्चिमी हिमालय क्षेत्र में लगाया गया। चार वर्ष की उम्र होने पर इसकी औसत प्ररोह ऊँचाई 151-279 सेमी० तथा व्यास 10-21 सेमी० तक पाए गए। विभिन्न स्थानों पर इसकी वृद्धि में काफी अन्तर स्पष्ट दिखाई दिया जो स्थान की ऊंचाई में अन्तर रहने के कारण था। कम ऊंचाई वाले क्षेत्र (समुद्रतल से 790-1140 मी० ऊँचे) हिमालय प्रदेश में क्वे० सर्राटा लगाने के लिए अधिक उपयुक्त पाए गए।

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EFFICACY OF MONOCROTOPHOS AGAINST *AILANTHUS* WEBWORM, *ATTEVA FABRICIELLA* SWED. (LEPIDOPTERA : YPONOMEUTIDAE).

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Introduction

Atteva fabriciella Swed. is a serious pest causing large scale defoliation in the young plantations of *Ailanthus excelsa* Roxb. The severity of this insect was recorded in local nurseries and plantations. As a result of repeated defoliation the growth of the plant is seriously affected leading to death of the plant. The losses are also discovered on tender fruits during summer month. Mathur *et al.* (1970); Mishra (1973); Singh and Bhandari (1975) and Singh and Gupta (1978), have made important contribution on this insect. The present investigation deals with the trial of an insecticide monocrotophos (Nuvacron 36 E.C.) at various concentrations in the laboratory and field conditions for controlling this insect.

Materials and methods

In the present study only one insecticide monocrotophos (36 E.C.) a broad spectrum organophosphatic insecticide has been tried. It has both systemic and contact action. As per the manufacturer note, over 50% of material is absorbed in the plant system within 24 hours. Approximately 30% remains on plant surface as a residual deposit killing by contact poison. The remaining 20% appears to be lost and does not play any role. The laboratory evaluation with this insecticide against the *Atteva fabriciella* was made after Singh and Gupta (1978). The desired concentrations of the monocrotophos were obtained by diluting the insecticidal formulation with tap water. In case of control experiments water alone was used. The larvae of *A. fabriciella* were collected from heavily infested trees of *Ailanthus excelsa* in the campus of R.F.R.C., Jabalpur for laboratory and field experiments with different concentrations of monocrotophos (0.005%, 0.01%, 0.0125% and 0.02%). The larvae were not separated into different instars. The trials were conducted in three stages : (1) Plants were treated with insecticides at different concentrations in the field using pneumatic hands sprayers (1 lit. capacity). In one test i.e. 1 lit. of solution was sprayed. After 5 minutes, larvae in groups of ten each were released on the plants sprayed with different concentration of the insecticide solution to observe the mortality of *A. fabriciella.* (2) Larvae from treated plants in the field were fed to third instar for 24, 48 and 72 hours respectively in petridishes (10 cm dia) at room temperature. The leaves were plucked 24 hours after the treatment being fed to the larvae. The leaves were changed once every day. (3) The leaves treated directly in the four concentrations were fed to the larvae to monitor of *A. fabriciella.* Leaves treated with water as fed to the larvae served as control. The spray was allowed to dry for

about 5 minutes and the larvae were then released into the petridishes containing these leaves. Mortality data were recorded at intervals of 24, 48 and 72 hours respectively.

Results and Discussion

The mortality data obtained 24, 48 and 72 hours after treatment are presented to Table 1. The table indicates that in the field condition 0.005% monocrotophos gave 30% mortality within 24 hours whereas 0.01% and 0.0125% of this insecticide exhibited 36 and 50 per cent mortality within 24 hours. However, 80 and 100 per cent mortality was recorded in 24 and 48 hours respectively by applying 0.02% concentration. Singh and Bhandari (1975) recorded 80-100 per cent larval death of *A. fabriciella* by using 0.2% water solution of Endosulfan after 24 hours and 48 hours respectively. Monocrotophos at 0.005%, 0.01% and 0.0125% gave mortality 56, 80 and 86% respectively within 72 hours. In control the larvae fed on leaves treated with water only. It appears from this fact that the larvae died because of the contact action of the insecticide. On the basis of stage 2, it was observed that 80 and 100 per cent mortality was recorded at 0.02% monocrotophos within 24 hours and 48 hours respectively in laboratory condition. Its 0.005%, 0.01% and 0.0125% concentration gave 50, 73 and 83% mortality in 72 hours.

The treated leaves from the field were fed to third instar larvae which indicated that 0.02% monocrotophos was most effective than the other concentrations used viz. 0.005%, 0.01% and 0.0125% (Table 2). On the basis of stage 3, the same concentrations of monocrotophos

Table 1

Effect of various concentrations of monocrotophos against the larvae of A. fabriciella.

Insecticide	Concentration	Total percentage of larvae dead (3 replications) after (in field condition)			Total % of larvae dead (3 replications) at room temperature (leaves directly treated in laboratory) after		
		24 hrs	48 hrs	72 hrs	24 hrs	48 hrs	72 hrs
Monocrotophos	0.005 %	30.00	16.66	10.00	30.00	20.00	13.33
(36 E.C.)	0.01 %	36.66	30.00	13.33	33.33	26.66	20.00
	0.0125%	50.00	16.66	20.00	53.33	26.66	6.66
	0 02 %	80.00	20.00	—	66.66	23.33	10.00
	Control	0	0	0	0	0	0

Table 2

Effect of various concentrations of monocrotophos against the larvae of third instar at room temperature (leaves from field were fed to only third instar larvae)

Insecticide	Concentrations	Total % of larvae dead (3 replications) after		
		24 hrs	48 hrs	72 hrs
Monocrotophos (36 E.C.)	0.005 %	23.33	20.00	6.66
	0.01 %	40.00	20.00	13.33
	0.0125%	60.00	13.33	10.00
	0.02 %	80.00	20.00	—
	Control	0	0	0

were used and leaves directly treated and fed to the larvae in laboratory condition showed 100% mortality upto 72 hours with 0.02% monocrotophos. Its 0.005%, 0.01% and 0.0125% gave 63, 80 and 86 per cent mortality respectively, Monocrotophos (40° E.C.) proved 22.9218 (relative toxicity) times more effective than DDT, Pyrethrum, Carbaryl etc. (Singh and Gupta, 1978). In this case larvae did not feed on the treated leaves except control (Table 2). Therefore, monocrotophos 36 E.C. @ 0.02% may be used for protecting *Ailanthus excelsa* plants against *Atteva fabriciella*. However, in the present study differential effect of various concentrations of monocrotophos (36 E.C.) on various instars larvae of *A. fabriciella* was not investigated. The same is under investigation and will be reported separately.

SUMMARY

Four concentrations viz. (0.005%, 0.01%, 0.0125% and 0.02%) of monocrotophos (36 E.C.) were tested as contact and systemic action against the larvae of *Atteva fabriciella* in field and laboratory conditions at room temperature. On the basis of experimental findings 0.02% monocrotophos exhibited 80 and 100 per cent mortality within 24 and 48 hours in field condition. The same treated leaves from field when fed to third instar larvae in the laboratory condition gave 80 and 100 per cent mortality after 24 and 48 hours respectively. The leaves directly treated in the same conditions at room temperature also gave 100 per cent mortality after 72 hours. *Atteva fabriciella* may be successfully controlled by applying 0.02% monocrotophos (36 E.C.) in the nurseries and growing plantations of *Ailanthus excelsa*.

एलेन्थस जाल कृमि एटीवा फेब्रिसियेला स्वेड० (शल्किपक्षा : यूपोनोमायटिडी) के विरुद्ध मोनोक्रोटोफोस की कार्यक्षमता

पी०बी० मेश्राम व जमालुद्दीन

सारांश

मोनोक्रोटोफोस (37 ई०सी०) के चार संकेन्द्रणों (0.005%, 0.01%, 0.0125% और 0.02%) को क्षेत्र तथा प्रयोगशाला दशाओं में कमरे के तापमान पर एटीवा फेब्रिसियेला के जातकों के विरुद्ध स्पर्श और विधिवत सक्रियता रूप में परीक्षित किया गया। संपरीक्षण से मिली जानकारी के आधार पर 0.02% मोनोक्रोटोफोस से क्षेत्र दशाओं में 24 और 48 घंटों में क्रमश: 80 व 100% जातक मर गए। उसी से उपचार की गई पत्तियाँ तीसरे-रूप जातक को प्रयोगशाला में खिलाने पर क्रमश: 24 और 48 घटे बाद क्रमश: 80 और 100% जातक मर गए। कमरे के तापमान पर उसी अवस्था में प्रत्यक्षत: उपचारित पत्तियों से 70 घंटे बाद भी जातक मरण 100% रहा। एटीवा फेब्रिसियेला को 0.02% मोनोक्रोटोफोस (36 ई०सी०) प्रयोग करने पर एलेन्थस एक्सेल्सा की रोपणियों और वृद्धिशील रोपवनों में सफलतापूर्वक नियन्त्रित किया जा सकता है।

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LITSEA GHATICA SALDANHA—A NEW DISTRIBUTIONAL RECORD TO KERALA STATE

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While undertaking the floristic survey of the forests of Kerala State in connection with the revision of the forest flora, the authors came across an interesting taxon of *Litsea* in the evergreen forests of Begur Range, Wynad Forest Division. Though the taxon had very close similarity to the common species, *Litsea deccanensis* Gamble, on careful examination of the specimens it was found to be different. Critical study with the help of literature and on comparison with specimens deposited in the Madras Herbarium and Central National Herbarium, Calcutta, it was found to be distinct from *Litsea deccanensis* Gamble and identified as *Litsea ghatica* Saldanha. This taxon was first described from Charmadi ghat and Vanagur area of Western Ghats in Karnataka State. *Litsea ghatica* Saldanha is closely allied to *Litsea deccanensis* Gamble but can easily be distinguished by the characters as below.

Litsea ghatica Saldanha is a constituent of the evergreen forest unlike *Litsea deccanensis* Gamble, which is restricted to drier zones at lower elevations. The common associates of *Litsea ghatica* Saldanha are *Chasalia ophioxyloides* (Wall.) Craib, *Glycosmis pentaphylla* (Roxb.) DC., *Crotalaria retusa* L., *Xanthophyllum flavescens* Roxb., *Artocarpus heterophyllus* Lam., *Artocarpus hirsutus* Lam., *Elaeocarpus tuberculatus* Roxb , *Elaeocarpus serratus* L., *Calamus* sp., *Litsea floribunda* (Bl.) Gamble etc. The present report of the plant from Begur Range of Wynad Forest Division, Kerala State is an extended distribution of this taxon to the southern region of the western ghats It will be very interesting to watch the occurrence of the plant in other parts of the western ghats and other similar eco-climatic zones to study its

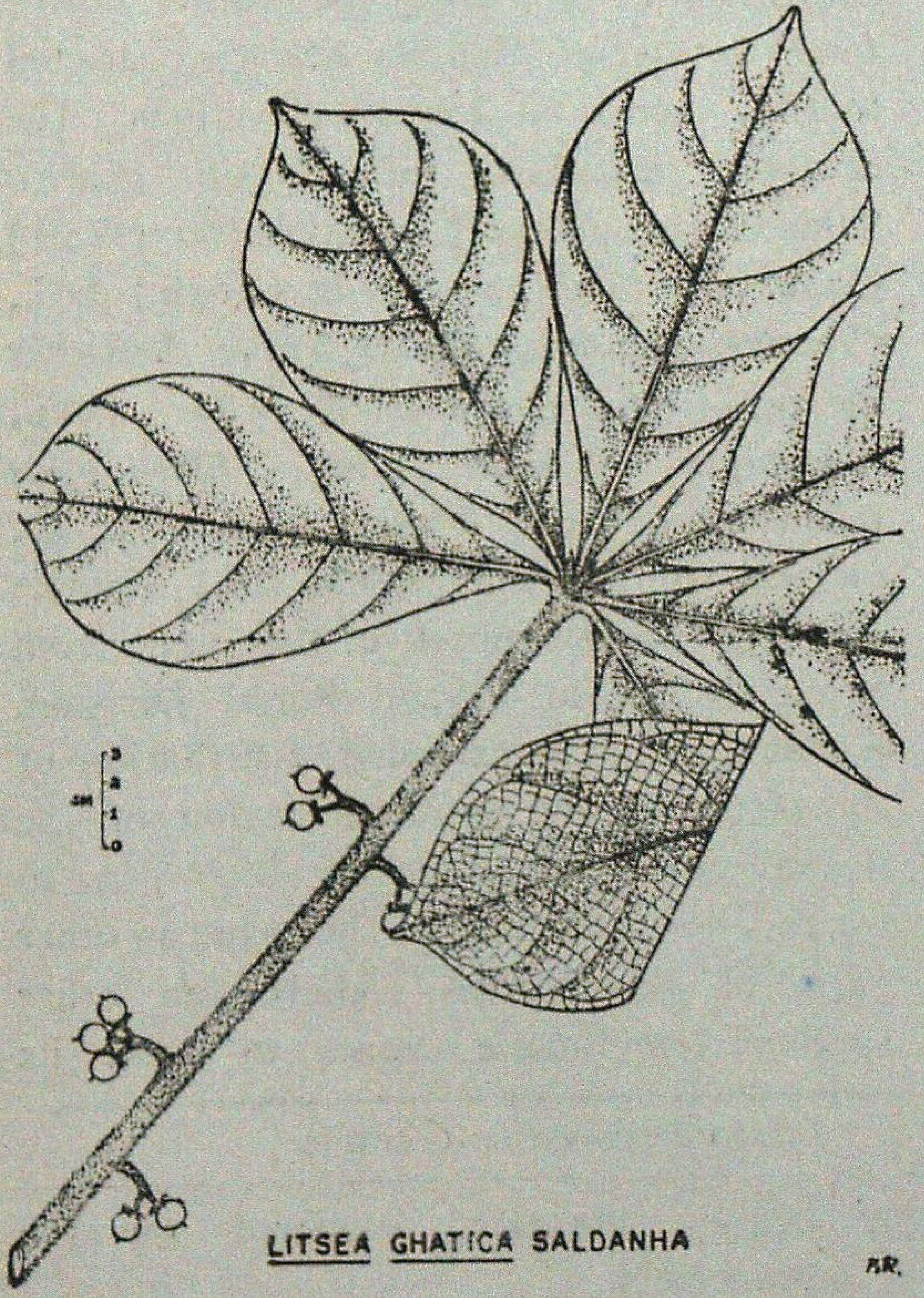
Litsea ghatica Saldanha	*Litsea deccanensis* Gamble
1. Leaves subverticillate at the end of branchlets.	1. Leaves alternate, scattered on the branchlets.
2. Leaves obovate, abruptly acute at apex, cuneate at base.	2. Leaves elliptic with abruptly acuminate apex and acute base.
3. Lateral nerves of leaves ending in distinct loops at the margins.	3. Lateral nerves end openly or obscurely confluent.
4. Petioles 1 cm long.	4. Petioles 2 cm long.

distribution pattern. This interesting and new taxon has to be protected and preserved.

A short description of the plant with a simple sketch is provided for easy location and identification of the plant in the field.

Litsea ghatica Saldanha, Fl. Karnataka 1 : 67. 1984.

Medium-sized trees. Young shoots whorled, light brownish tomentose, rapidly elongating from a row of terminal scales. Leaves subverticillate at the ends of branchlets to 20 × 11.5 cm, abovate, abruptly acute at apex, cuneate at base, glabrous above except on the midrib and lateral nerves, pubescent beneath; lateral nerves 8-10 pairs, distinctly looped near the margin on the lower side, nervules parallel. Penduncles tomentose, scattered along younger shoots below the cluster of leaves, often curved. Umbels 3-4 flowered. Flowers dull green, 1.4 cm across. Bracts lanceolate, caducous. Tender fruits green, globose, 0.5 cm across, apiculate. Perianth lobes persistant at the base of the tender berries.



LITSEA GHATICA SALDANHA

No information on the economic utility of the species is available. However, many species of Lauraceae are economically important and therefore the utility of this species is worth studying.

Fls. & Frs. August-December.

Distribution : South West India.

Specimens examined : FRC 9751, 10533, Begur Range (900 m) Wynad Forest Division, Kerala State. The specimens are deposited in the Forest Research Centre Herbarium (FRC), Coimbatore.

SUMMARY

***Litsea ghatica* Saldanha hitherto recorded from the Western Ghat area of Karnataka is now traced from further south in Wynad Forest Division, Kerala State. A brief description of the taxon for easy indentification and the salient differences of the same with *Litsea deccanensis* Gamble, a closely allied species, are given. The need for the conservation and protection of the species is highlighted.**

लिटसिया घाटिका सल्डाना—केरल राज्य में इसके होने का नया आलेख

के०एन० सुब्रमनियन, वी गुरदेव सिंह, एन वेंकटसुब्रमनियन व के०आर० शशिधरन

सारांश

लिटसिया घाटिका सल्डाना जो पहले कर्नाटक में पश्चिमी घाट से मिलता आलेखित किया गया था अब उसे केरल राज्य के वाईनाड वन मण्डल में भी खोजा गया है। आसानी से पहचान करने के लिए इस नई जाति का संक्षिप्त वर्णन इस जाति से बहुत निकट की मिलती जुलती दूसरी जाति लिटसिया डेक्कनेंसिस गैम्बल से इसके मुख्य अन्तर दिए गए हैं। इस जाति को सुरक्षित करने तथा इसको बचाने की आवश्यकता पर भी बल दिया गया है।

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RESEARCH NOTES

(I)

GERMINATION BEHAVIOUR OF *BUDDLEJA ASIATICA* LOUR —A PROMISING SHRUB FOR REGREENING OF DEGRADED HABITATS

Buddleja asiatica (family Loganiaceae) is a large, densely branched evergreen shrub, distributed in outer Himalayas ascending up to 1500 m commonly found in degraded, habitats like landslips, mined areas, ravines deserted taungyas, etc. It has proved to be a good colonizer on phosphorite mine over-burdens in Doon Valley (Soni and Vasistha, 1987).

The plant flowers during the month of February-March and its fruit and seeds mature during April-May. The fruit is a capsule, 0.5-0.7- cm long and containing on average 202 seeds, the seeds are light in weight, with size ranging between 543-941 μ.

Material and Methods

The fruits were collected during second week of May from Maldeota (18 km North-East of Dehra Dun) and allowed to sun dry in enamel trays. Within 4-5 days the seeds were released. To study the germination, viability and possibility of seedling development, tests were carried out both in laboratory and polybags (glass-house condition).

In laboratory, the germination tests were carried out in petridishes on sand media at room temperature with four replicates of 200 seeds per dish. The media was kept moist throughout the experiment and seed germination percentage and viability record for eight months (July-Feb.) as given in Table 1.

Table 1

Seed germination and viability of Buddleja asiatica

Sl. No.		Month of sowing	Commencement of seed germination (days)	Average germination (%)
1.	Laboratory (in petridishes)	July	7	60
		August	8	57
		September	10	60
		October	8	54
		November	16	33
		December	—	—
		January	16	19
2.	In glasshouse (in polythene bags)		12	21

Under glasshouse condition the seeds were sown in polythene bags during the month of October, with 22 polybags filled with soil, sand and manure in the ratio of 2 : 1 : 1. Thirty number of seeds were sown in each polybag (since seeds were very small) and watering was done as and when required. Seed germination was recorded in 21 polybags out of 22 bags. Seedlings height and diameter were recorded for four months (November-February (Table 2).

Table 2

Seedling height and diameter of Buddleja asiatica under glasshouse conditions

Age of Seedlings (months)	Average height (cm)	Average diameter (cm)
1	4.6	0.18
2	4.8	0 22
3	20	0.31
4	27	0.43

Results and Discussion

Results from Table 1 show that *Buddleja asiatica* seeds are non-dormant. The commencement of germination and percentage germination is more or less similar for first four months (July-Oct.) but gradually decreases in the subsequent four months. This may be atributed to low atmospheric temperature of the later months. On the other hand seeds germinated in October in the polybags showed considerable growth from the month December to February. i.e., height increased from 4.8 cm to 27 cm and diameter also became almost double from 0 22 cm in December to 0.43 in the month of February (Table 2).

These observations showed that once the seed has germinated, low atmosphere temperature and comparatively smaller photoperiods (during winter months) are not a constraint for the fast growth of this species both in form of height and diameter. Growth response during first four months after germination gives a positive indication of the possibility of large scale polybag planting in the field. The significant increase in height and diameter of the seedlings during the first four months (winter season) seems contrary to the general growth trend of most of forest tree species studied in North India. However, initial high growth rate during winter months resembles that of some semi-evergreen to evergreen species e.g. *Hopea parviflora* in which north-east monsoon (Oct-Nov.) causes peak growth period (Champion and Seth, 1968).

However, this can be confirmed only after observing plant growth in polybags for at least one year and subsequent field trials.

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(II)

A NOTE ON SEED GERMINATION AND INITIAL GROWTH RATE OF INDIAN HORSECHESTNUT (*AESCULUS INDICA*, COLEBR.).

Indian horsechestnut (*Aesculus indica*, Colebr.) a common associate of temperate broadleaved species such as *Juglans regia*, *Acer caesium*, *Prunus cornuta*, as well as conifers like *Abies pindrow*, *Picea smithiana*, *Taxus baccata*, *Cedrus deodara* and *Pinus wallichiana* grows in the North-western Himalayas at an elevation ranging between 1240-2790 m (Troup, 1921). In hills, it is mainly cultivated for ornamental purposes. However, by virtue of its faster growth rate, it holds potential for raising mixed plantations along with spruce and silver fir in the spruce-silver fir zone. Information on seed germination and initial growth rate of this species is not available, therefore, this research note deals with these aspects.

The seeds of horsechestnut were sown in early December, 1986 in Shillaru nursery (2400 m) in ten raised nursery beds having an area of 1 × 1 m each. Ten seeds were sown at 10 cm distance in lines spaced 30 cm apart in each nursery bed. Nursery beds were watered thrice a week. The soil in the nursery beds was loosened frequently and weedings were done regularly. Two seeds were also sown at a spacing of 10 cm in one hundred fifty seed beds of 30 × 30 cm size each in the field situated in the Narkanda forests in the month of December, 1986. At the end of first growing season, one hundred seedlings each from the nursery as well as the field were selected at random for recording of the growth data. For dry weight determination, twenty sample seedlings each from the nursery as well as the field were taken at random and dried in an oven at 80°C to a constant weight.

The seed germination in the nursery beds started in the first week of March, 1987 and was complete in about a month. The mean maximum and minimum temperatures recorded in the nursery during the germination period were 12.6°C and 6.3°C respectively. The seed germination in the field started in the last week of April, 1987 and was complete in about one and a half months. The difference in speed of germination in two cases may be due to the variation in moisture availability under two different conditions. Table 1 gives the germination percentages and plant per cents recorded in two cases.

Table 1

Location	Germination percentage	Plant per cent
Nursery (Shillaru)	72.37	71.00
Field (Narkanda)	71.00	71.00

The germination percentages and plant per cents recorded in two cases are comparable. The germination percentage and plant per cent recorded in different species of horsechestnut in America varied from 56-89 and 70 respectively (USDA, 1974). Table 2 summarises the growth data and dry weights in two cases.

The mean seedling height recorded in the nursery and in the field were 32.73 cm and 20.15 cm respectively, whereas the mean collar dimeter recorded in two cases were 0.90 cm and 0.79 cm respectively It is evident that the nursery grown seedlings exhibit better growth in height and diameter as compared to the seedling growth in the field. The differences in seedling dry weights in two cases indicate that the higher seedling dry weights in the nursery may be attributed to the proper care and timely executed nursery operations. However, this initial advantage would be neurtralised subsequently as a results of conditioning of nursery grown seedlings in the field. Nevertheless, the results of this study indicate that horsechestnut seeds can be sown directly in the field to supplement the artificial planting as well as to fill up casualty gaps in the plantations in subsequent years.

Table 2

Seedling length and its dry weights

Location	Mean seedling height (cm)	Mean seedling colar diameter (cm)	Shoot dry weight (gm)	Root dry weight (gm)
Nursery (Shillaru)	23.73 ± 6.76	0.90 ±0.17	3.09 ±1.50	3.82 ±2.06
Field (Narkanda)	20.15 ± 5.94	0.79 ±0.17	2.89 ±1.26	2.72 ±0.73

References

Troup, R.S. (1921). *The Silviculture of Indian Trees*, Vol., I., 226-228, Clarendon Press, Oxford.

U.S.D.A. (1974). Seeds of Woody Plants. *Agri. Handb.* 450 p. 195-199.

Conifers Research Centre,
Shimla (Himachal Pradesh).

S. Bhagat,
Ombir Singh,
and Virendra Singh

LETTER TO THE EDITOR

To,

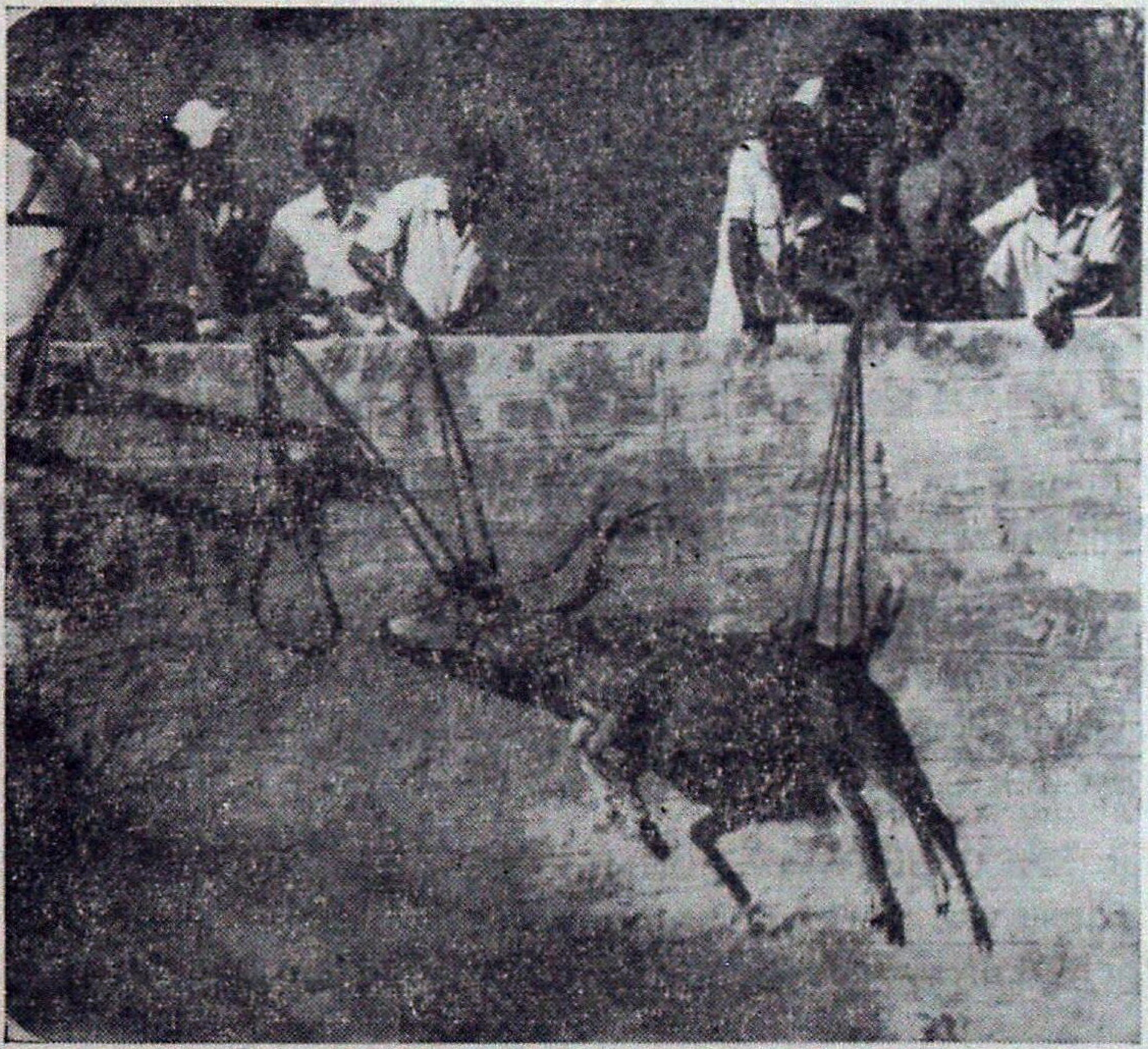
The Hony. Editor,
Indian Forester,
P.O. New Forest, Dehra Dun.

Sub : **Operation rescue of spotted deer from a well**

Sir,

One summer morning at about 5.30 a.m. in the Nagarjunagar—Srisailam Tiger Reserve, the Forest Range Officer, Mannanur was informed that a big male spotted deer has been chased by pack of wild dog and it has jumped into the well to save itself from the wild dogs. Forest Range Officer, immediately rushed towards the well. Incidently, I also reached to the spot. I saw the spotted deer which was of a big size swimming in the well and struggling to survive. I found that there is nothing on which it can take rest and once swimming stops it will be drawn in the water. I immediately instructed the

Forest Range Officer to bring the ropes. The deer was restlessly swimming in the well without stopping. With great difficulty the rope was put into the antlers with the help of the sticks and pulled it towards the wall of the well so that its movement can be arrested and given some rest. As due to continuous swimming is got exhausted completely. Rope was also put under its stomach near the hind legs and another rope on



its antlers again. The spotted deer was then pulled out from the well at 9.00 a m. It was almost unconcious. The ropes were removed. After sometime it got up, saw all around and ran. We followed it to some distance and when we were satisfied that it has gained normal sense and joined its habitat we came back. Due to timely operation, we could save the life of the animal.

Yours faithfully,

Sd./– Shri Qamar Mohd. Khan,
Asstt. Director,
Project Tiger, Achampet (Andhra Pradesh)

GAZETTE NOTIFICATIONS

ANDHRA PRADESH GAZETTE

The following transfers and postings of Conservators of Forests are ordered with immediate effect.

(1) On return from leave, Shri B. Malla Reddy, I.F.S., is posted as Conservator of Forests, Nizamabad Circle vice Shri C. Subba Rao, I.F.S.

(2) The orders issued posting of Shri C. Subba Rao, I.F.S., as Conservator of Forests, Adilabad are cancelled and he is now transferred and posted as Conservator of Forests (Forest Resources & Industries) in the O/o the Prl. Chief Conservator of Forests, vice Shri C. Sivasankara Reddy, I.F.S.

(3) On transfer, Shri C. Sivasankara Reddy, I.F.S., is posted as Conservator of Forests, Adilabad Circle vice Shri S.D. Mukherji, I.F.S., already transferred and posted as Conservator of Forests, Warangal Circle.

(4) The services of Shri K. Rajasekhar, I.F.S., who has been appointed as Chief Conservator of Forests (Central), Shillong on deputation to Govt. of India are withdrawn from M/s. Singareni Colleries Company Ltd., Kothagudom from the date of relief.

KARNATAKA GAZETTE

On repatriation from Government of India Shri K.P. Nagaraju, I.F.S. is appointed with immediate effect and until further orders as Deputy Conservator of Forests, Social Forestry Division, Zilla Parishad, Gulbarga in the existing vacancy.

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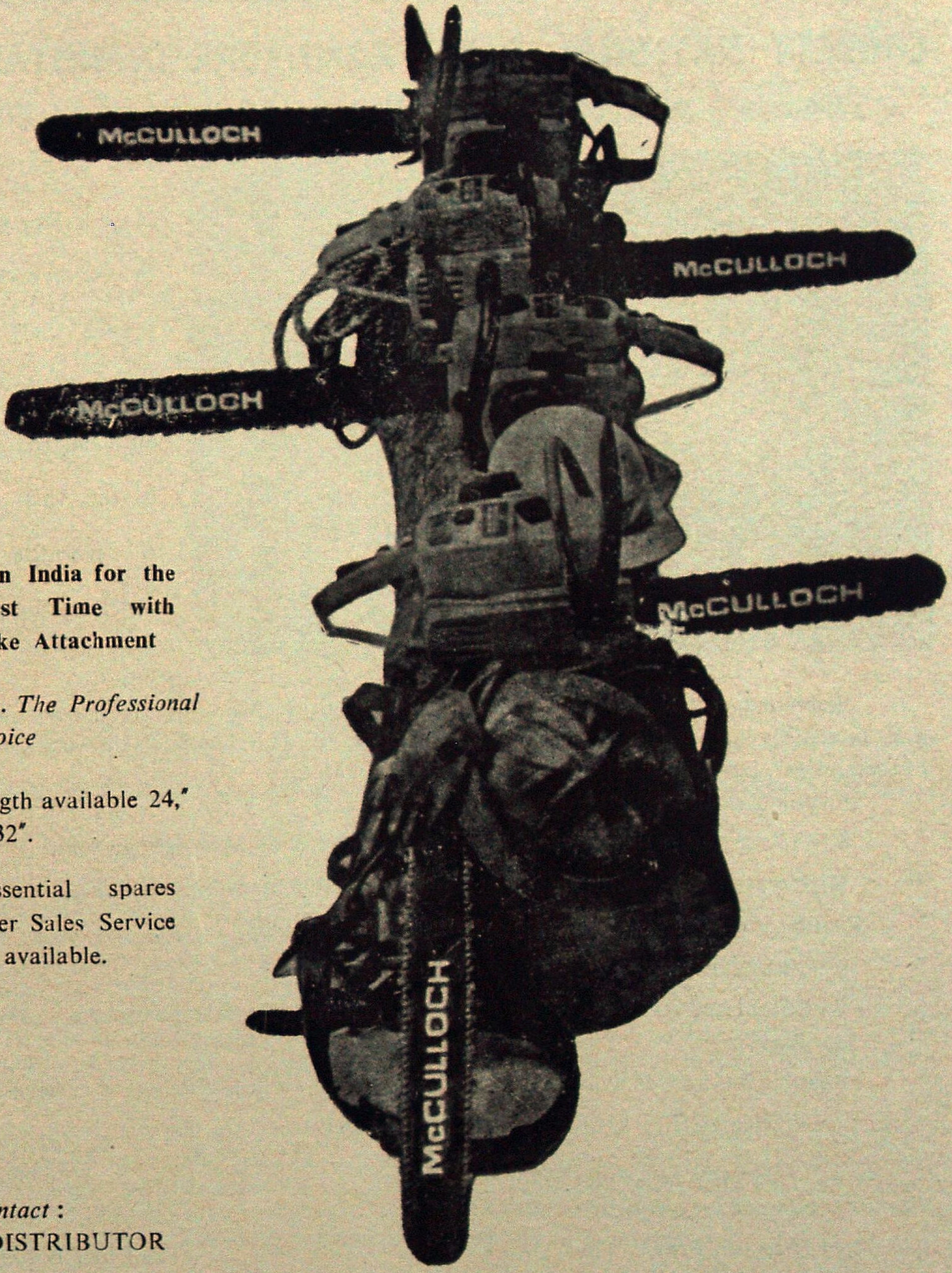

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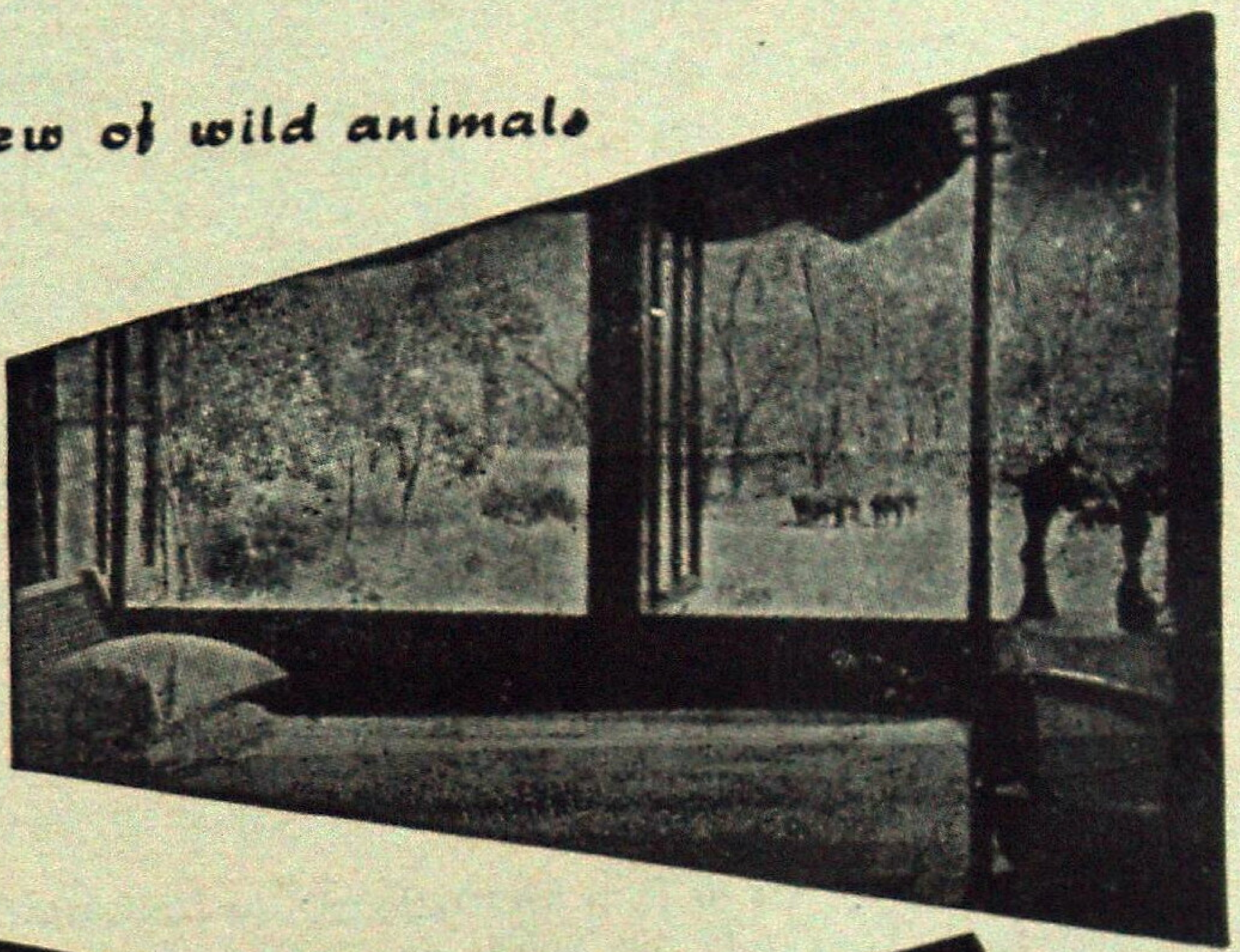

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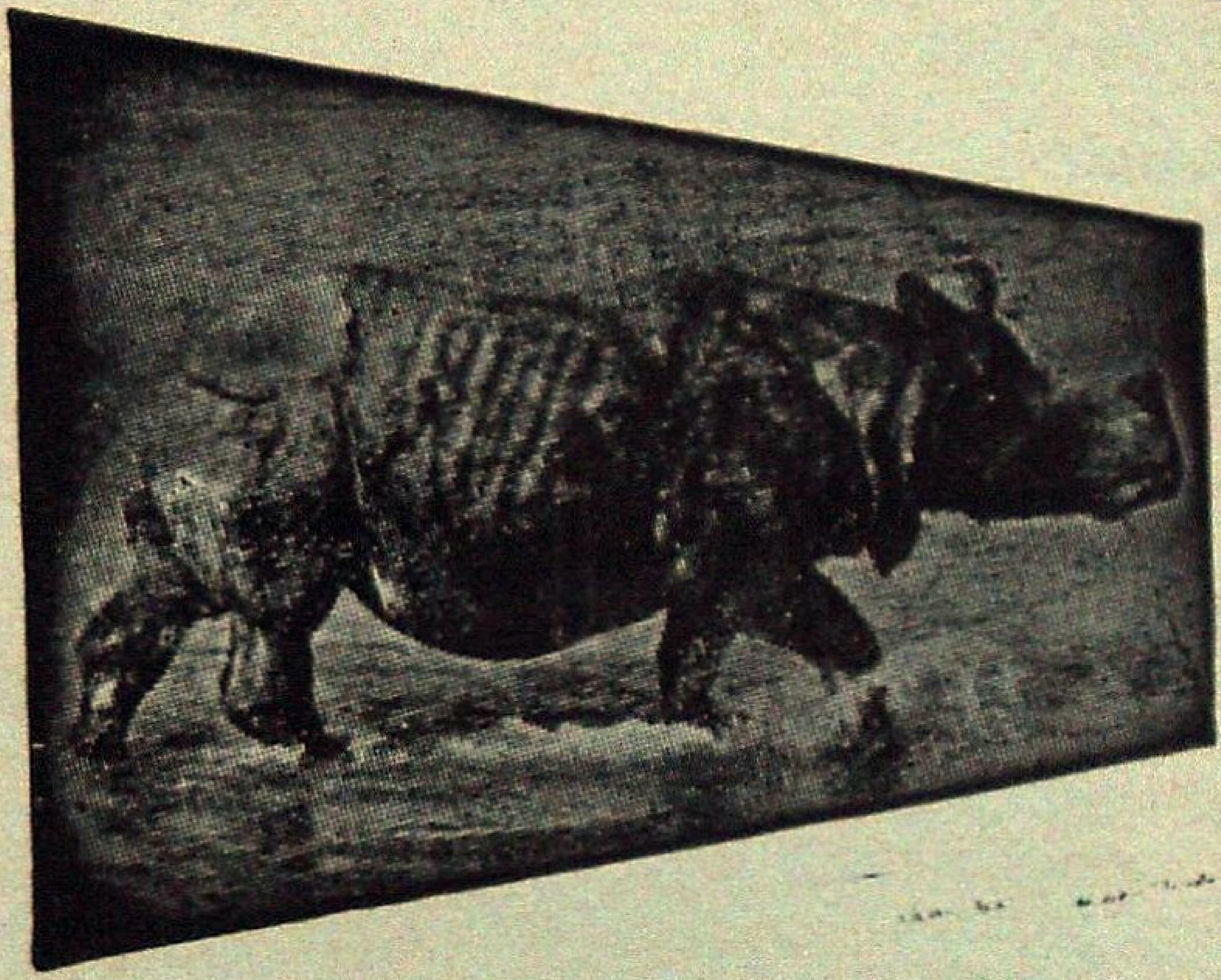

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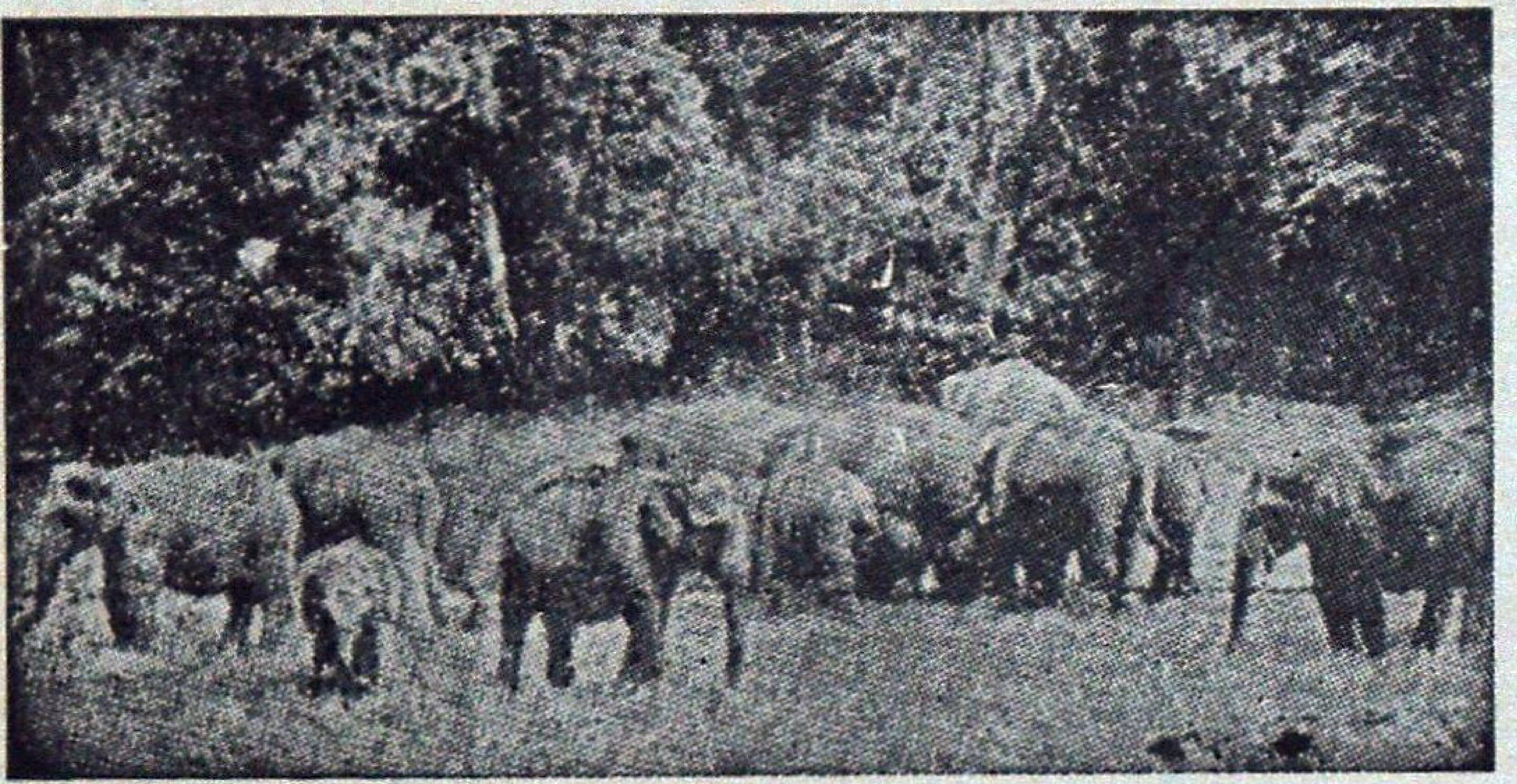

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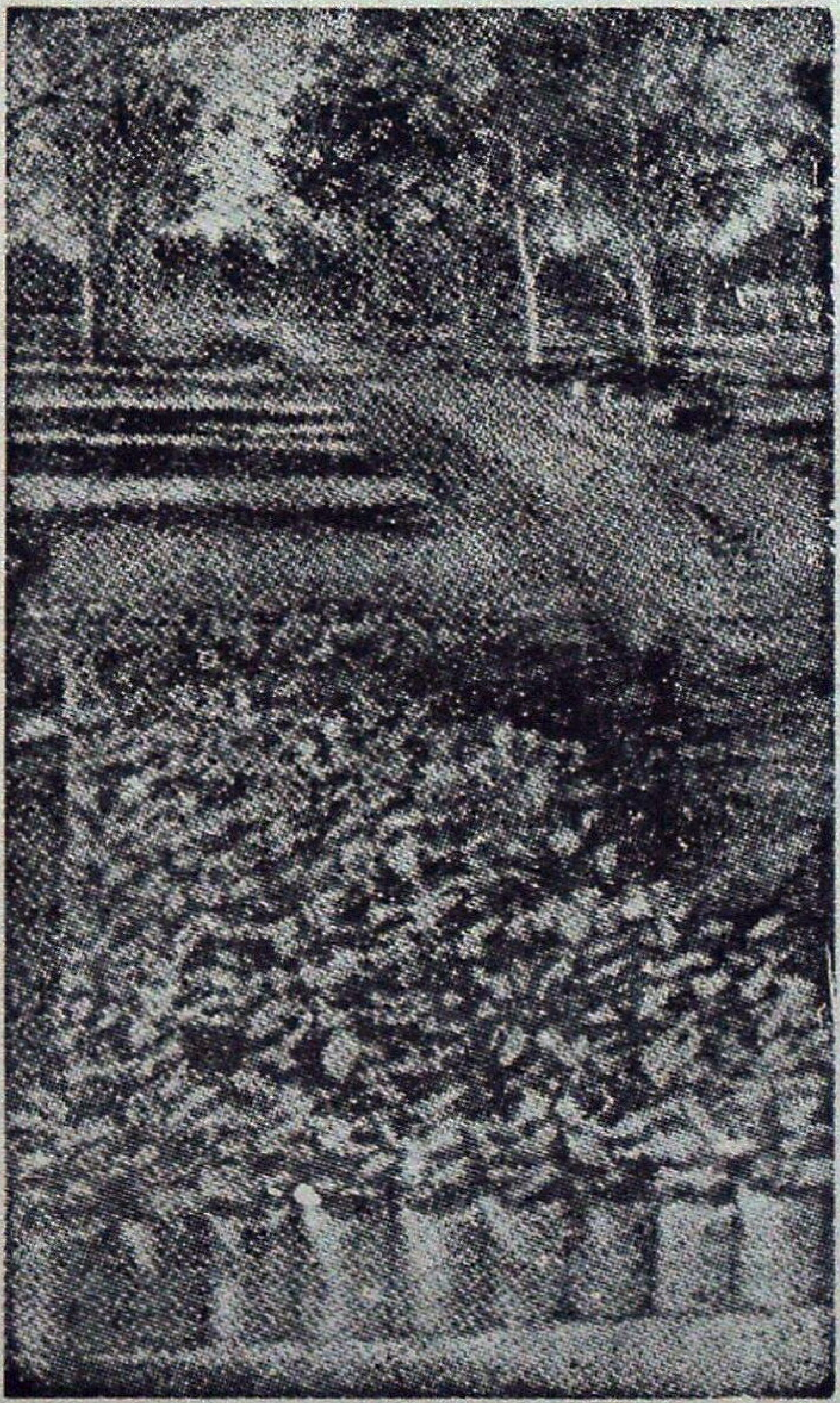

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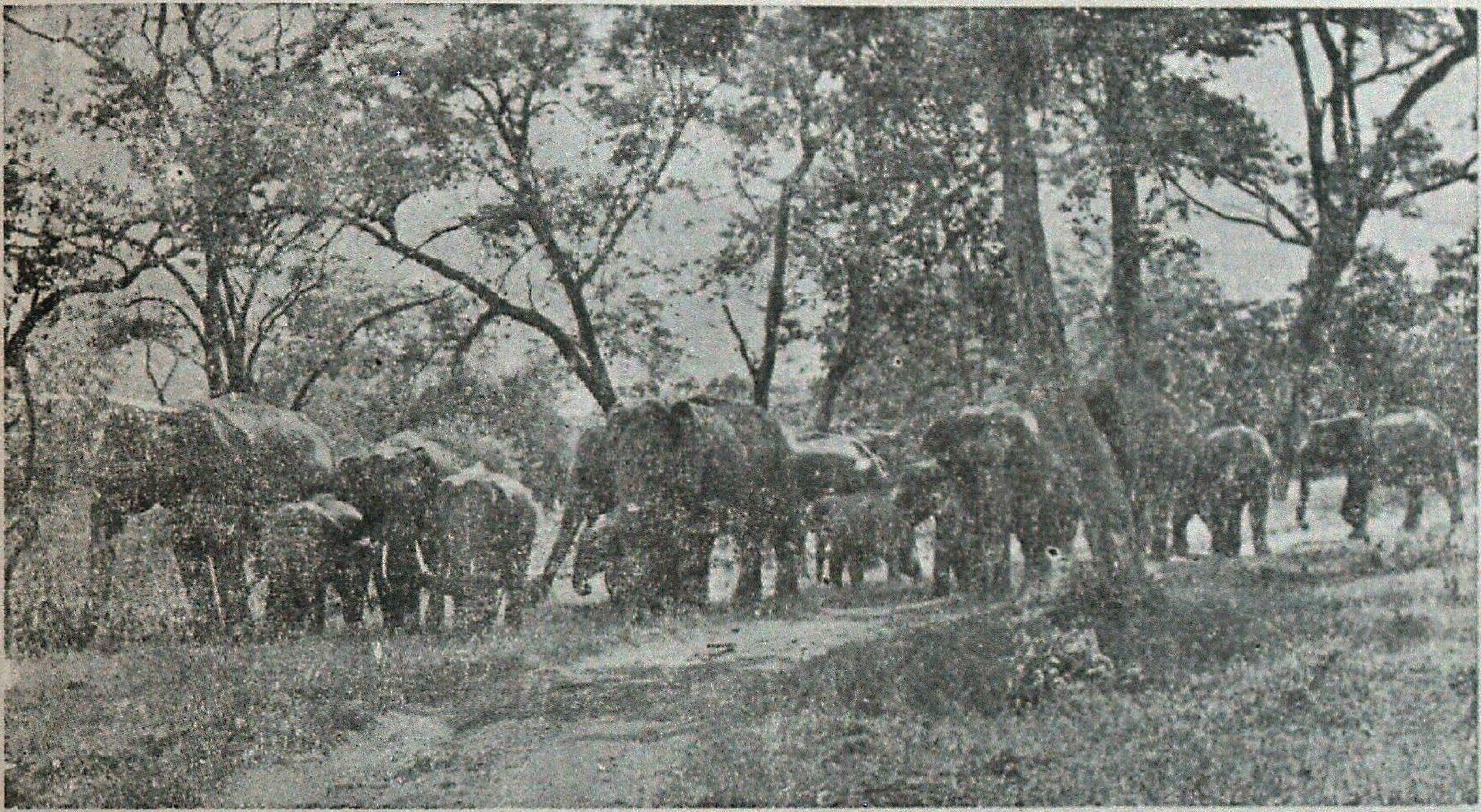

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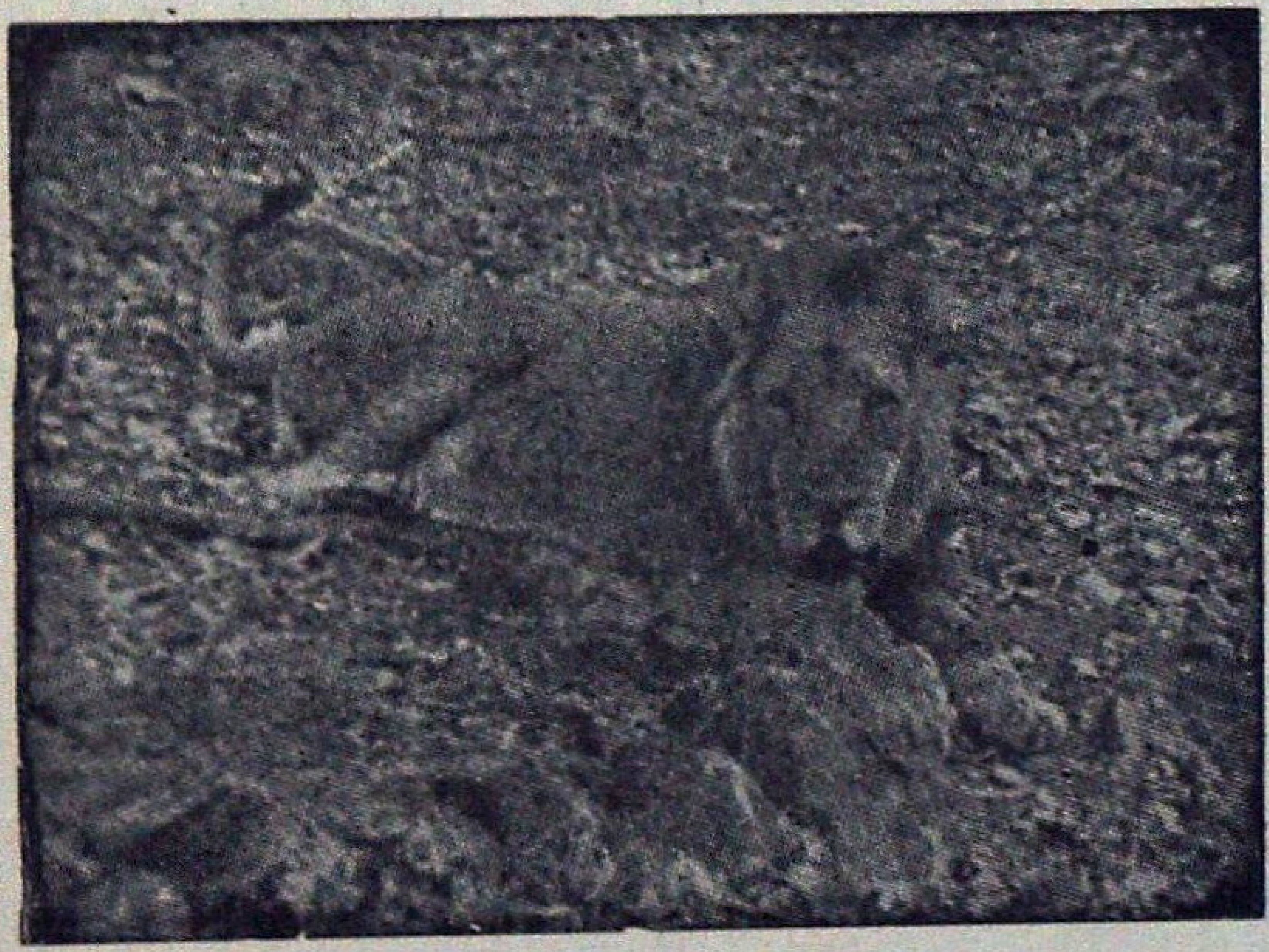

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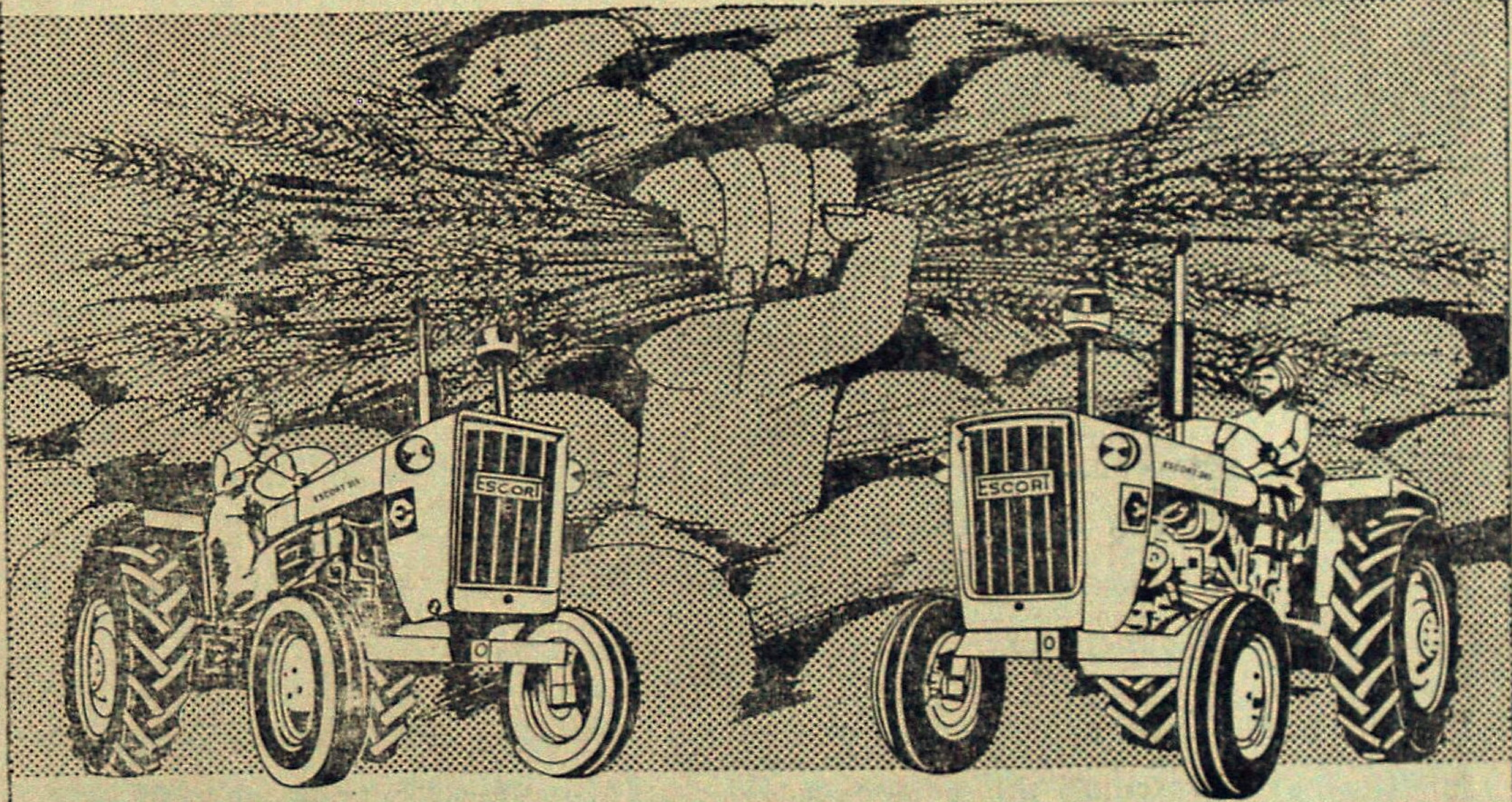

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